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USSR Report

CYBERNETICS, COMPUTERS AND AUTOMATION TECHNOLOGY

(FOUO 4/81)

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CONTENTS

HARDWARE

VLSI K1801VE1-BASED ELEKTRONIKA NTS-80-01 AND ELEKTRONIKA-60 EXHIBITED

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, 1980 pp 40-42

[Article by engineers V. V. Kochin and V. T. Kuz'min]

[Excerpts] The main event of the year at the Exhibition of Achievements of the USSR National Economy was the Central Exhibition of Scientific and Technological Creativity of Youth (NTTM-80).

A whole gamut of industrial robots for instrument making and electronics has been developed and introduced by young innovators of the Central Scientific Research Institute of Electronics in Moscow.

The "Moment-1" industrial robot can be used with technological equipment which carries out the processes of stamping, checking and readjustment. It is intended for the transfer and restacking of articles, the loading of blanks into presses, etc. The robot has four degrees of freedom and a load capacity of 5 kg and provides a precision of positioning of ± 0.05 mm. Its series production is being prepared.

The PRP-0-1 is a pneumatic industrial robot capable of performing loading and unloading operations with articles of microelectronics. The minimum thickness of an article with which it can work is 0.5 mm, the cycle time is 3 s and the load capacity of the robot is 300 g. Both the pneumatic robots have a built-in control unit that permits control from a computer. In their parameters such manipulators are not inferior to the better foreign models, and there are no domestic analogous units. Original technological solutions included in their design are protected by patents.

The section "Instrument making and radioelectronics" is one of the most interesting and popular at the exhibition. And that is no accident. Instrument making now determines the rates of scientific and technological progress in all sectors of the national economy. The terms "original," "first" and "without equivalents" are applicable to many exhibits of this section.

Among the microelectronic components is the MDP-BIS [MDP=metal-dielectric-semiconductor] microprocessor unit series K581, developed by the Central Scientific Research Institute of Electronics. The unit includes BIS (large-scale integrated microcircuits) of five types and is intended for the construction of a 16-place microprocessor which is the controlling and processing part of the

"Elektronika-60" micro-computer. Each of the BIS contains a ROM, decoder and circuits for input and output data formation. They were worked out on the basis of p-channel technology with silicon locks and have been made in 48-pin packages. The unit permits constructing micro-computers with a broad set of peripherals and small dimensions, great universality and speed, program-compatible with 16-place mini-computers. Eight patients were used in designing the unit.

The MDP-SBIS [SBIS=VLSI circuit] of a single-crystal 16-place microprocessor of type KR581VE has a data processing unit, a mini-computer control unit and two microinstruction ROMs with a capacity of 11,264 bits each. It is intended for the creation of the microprocessor of the "Elektronika-60" micro-computer.

Widely displayed in the section were instruments for the functional monitoring of microprocessor systems and microcircuits in different stages of their manufacture and operation. Among them is the LA-2404 logic state analyzer, created by young scientists of the Uzbek SSR Academy of Sciences. It permits rapidly finding a defect in a microprocessor in any stage, from development to operation, or finding an error in the software during functioning with apparatus. In contrast with analogous Soviet and foreign devices the array investigated is displayed on the screen of a standard TV receiver in columns. The storage volume is 1536 bits. Test industrial lots of the analyzer are being issued.

Great interest was aroused by various samples of test apparatus: instruments for testing microcircuits, logical probes (including with digital indication), instruments for measurement of static parameters of semiconductor elements and microcircuits. Here one can distinguish a semiautomatic machine for the investigation of large-scale integrated circuits based on K133 microcircuits. It is intended for investigation of the functional possibilities of large-scale integrated circuits and performs a class of symmetric and linear functions of seven variables, and also the class of an algebraic logic of four variables.

The YaOS AMTs-1114 tester for functional dynamic monitoring is intended for the automatic monitoring of cells with homogeneous structure made in the form of YaOS 214T integrated circuits. It has been introduced at the "Elva" Scientific Production Association in Tbilisi, with an annual saving of 65,000 rubles.

A device for testing field-effect transistors measures their static parameters and permits taking the current-gate characteristics and selecting pairs of field-effect transistors. The error of measurement is $\pm$ 1 percent.

Equipment for automatic testing of the UAPP automatically monitors and detects error of a solid-state immediate-access memory. In contrast with equivalents, it monitors each element and makes it possible to determine the element containing an error.

In this section of the exhibit an important place was given to computer technology and support equipment. The "Elektronika NTs-80-01" single-plate computer system is intended for use in digital data processing systems based on the single-crystal K1801VE1 microcomputer with use of SBIS. The computer's speed is 300,000 operations per second, and there are 404 modifications of performed instructions. It has no

analogs in the Soviet Union or abroad in system characteristics. Enlargement, of the system via the main memory input-output bus is possible. The authors of the system are young scientists of the Central Scientific Research Institute "Elektronika."

The "Iskra-122-1," created by young innovators of the Kursk "Svetmash" Plant, makes very simple mathematical and economic calculations. A wider range of problems, including engineering problems, can be solved by using the "Iskra-2240," created by Leningrad workers; its elementary base is a large-scale printed circuit. The "Iskra-900" table-top terminal, with very simple data processing, serves for automation of the labor of members of middle and highest management. The device combines in itself the functions of an electronic keyboard computer, a digital clock-calendar, a telephone with automatic dialing and a very simple terminal which provides the exchange of digital data with a controlling computer complex by means of a coupling unit. It has a volume of 0.008 cubic meter. The "Iskra-900" is one of the first such devices and has no Soviet or foreign **equivalents.**

The PPZU-915 programming device is intended for the programming of semipermanent memory units with electrical recording and subsequent monitoring of data. It is applied in the development, production and operation of apparatus with microprocessors. A novelty of the device is the possibility of linkage with computers through a shared line. The programming device assures data recording in storages of different types with a capacity of up to 16K bits and has been developed for the first time in the Soviet Union. It is planned to start series production of it in 1981.

The universal automatic programming instrument assures data recording and control of semipermanent memory unit integrated circuits of types K155PE3, K556PE4, K556PE5 and K500PE149. It permits input monitoring of defects in integrated circuits and the selection of circuits with single defects. Data can be recorded from a keyboard, a photo reader, and a standard integrated circuit in both automatic and step-by-step conditions. The annual saving from the use of such instruments is 100,000 rubles. The instrument has no Soviet **equivalents.**

The APD 600/1200-01 data transmission apparatus was created by innovators of the "Telemekhanika" Production Association (Nal'chik). It is intended for the exchange of alphanumeric data between peripheral points and data processing centers over telephone channels. The areas of application are automated control systems, TP [not identified] and automated production and sector control systems. Connections can be made over commutated channels manually, semiautomatically or automatically. A distinctive feature of the apparatus is high reliability. The saving from introduction of a single device is over 3000 rubles per year. The originality of the technical solutions has been confirmed by four patents.

The digital computer data registration device for the MPU-16-2 miniature printer, based on microcircuits with a high degree of integration, has no Soviet **equivalents.**

Also developed for the first time in the Soviet Union is a digital computer data input-output device that has an operating speed of 500,000 bytes/s.

The BP-1 dc power pack provides power for a complex of ASUTP [automated control system for technological processes] hardware with use of the "Elektronika-100A", has three stabilized and six unstabilized channels, output

channel voltages of +9, -9, +10, +13, -15, -19 and -29 V and a capacity of 500 W, and differs from similar equipment by a built-in diagnostic and monitoring system.

The SM-1 computer signal simulator increases labor productivity by 60 percent. It is intended for checking working capacity, adjustment and regulation of interface units included in SM-1 and SM-2 computer complexes and accomplishing coupling with various peripherals.

The "Iskra-108" electronic keyboard computer (EKVM) monitoring desk was created at the Penza branch of the All-Union Scientific Research Technological Institute of Instrument-Making (VNIITIpribor) for technological verification and testing of the correctness of functioning of the EKVM. The work of 20 machines is verified simultaneously.

The higher precision and reliability are requirements presented for instruments and devices used in the production, recording and quality control of products.

A number of interesting developments were presented by the youth of the Penza branch of the VNIITIpribor. The AMTs-1521 coulometric coating thickness gage determines the thickness of coatings on finished products and permits checking coatings of silver, copper, zinc, cadmium and other metals on conducting and non-conducting bases, and also the thickness of two- and three-layer coatings with those metals. The thickness gage has small dimensions and mass. Original solutions used in creating it have been protected by patents. The instrument is universal and highly reliable. The saving from the introduction of one such device is 10,000 rubles per year.

A device for monitoring inter-turn shorts in coils of transformers of types Ua 4.709.020 and Ua 4.709.001 and similar types has been introduced at the "Uzhgorodpribor" Production Association, with a saving of 28,000 rubles per year. In comparison with similar devices it is characterized by higher sensitivity in the detection of short-circuited turns.

The Shch-304-8 digital voltmeter of the "Krasnodarskiy ZIP" Production Association does not have Soviet or foreign analogs, according to its characteristics. Its precision class is 0.02/0.05. It is intended for measurement of direct voltage. The value and its polarity are induced on an illuminated display. The amount of voltage is transmitted in binary decimal code to an external connector. The measurement range is 1 mV to 500 V. Its sensitivity is 0.1 microvolt.

The Shch 4313-03 converter of the Zhitomir "Elektroizmeritel'" Production Association imeni 50th Anniversary of the USSR permits measuring voltage and force of pulsed and sinusoidal current by a contactless method in printed plate conductors and integrated circuit leads protected by insulation coatings. It has a mass of 2.5 kg. Three patents have been obtained on the converter. Its series production was started in 1979.

The P-320 programmable calibrator also has been developed by young innovators of Krasnodar for measurement, three-position regulation and signalling on the output from a zone of direct current and voltage regulation. The instrument has a wide range of measuremnt: in current from 10 microamperes to 100 A and in voltage from 100 mV to 100 V. Information is issued in digital form. The minimum zone of

regulation is 1 percent. The area of application is a power system. Five patents were used in its design.

High-precision scale converter 74246 is an instrument with unique parameters. The conversion factors of input voltages are 0.001-100 and the maximum output voltage in corresponding ranges is 1050-0.12 V. The stability is 0.0001 V per hour. It can be used to check precision measuring instruments.

The Cheboksar "Elektropribor" Production Association has organized production of the F-4241 digital-analog converter for the first time in Soviet industry. Coded signals are converted into high-power direct current voltage. It is planned to organize series production in 1980.

The UKT-4 amplifier for contact thermometers and thermal contacts, produced by the "Termopribor" Scientific Production Association (L'vov) accomplishes two-position temperature regulation and signals regarding prescribed temperature conditions in dryers, heat chambers, heating furnaces, etc. It is used in a set with a mercury contact sensor. The saving from introduction of the device, thanks to longer service life of the sensor, is 213,000 rubles per year.

An infrared diagnosis instrument measures without contact the temperature of components of electrical equipment and the technical state of equipment can be judged from the temperature.

The TVP-6 precision water thermostat permits creating a thermostatted medium during the checking and calibration of sample and working means of measurement for scientific investigations requiring especially small temperature gradients of the working space. The range of its working temperatures is from -10 to +95°C, the volume of the working space is 50 dm^3 and the temperature gradients are $4 \cdot 10^{-2}$ °K per meter. It has no Soviet equivalents.

The digital electromagnetic thickness gage created by young scientists of the BSSR is convenient and reliable. It permits monitoring the thickness of a galvanic coating of chromium and other metals on non-magnetic articles. The thickness of the measurable coating is 0-300 mu and the measurement error is 5 percent. The instrument automatically selects and switches the range of measurements, depending on the coating thickness.

The I-713 measurement cell is intended for the measurement of the relative dielectric constant and the tangent of the angle of dielectric losses of solid dielectrics with accuracy of ± 0.5 percent. With it standard samples of dielectrics can be tested. The saving from introduction of the I7-13 cell was 30,000 rubles per year.

In the EZD-5 electromagnetic pressure controller the piston is loaded by an electromagnetic mechanism. It can be used to test manometric instruments. The pressure settings range is 0.01-1.00 kg(force)/cm^2.

The AZD-4 instrument gives precise discrete values of pressure during the adjustment, calibration and testing of instruments and the taking of characteristics of elastic elements. A contactless control circuit is used in it. It has no equivalents. The precision class is 0.05 percent.

2174
CSO: 1863

UDC 681.3.05:681.327.68:788.38

DIGITAL OPTICAL DATA PROCESSING WITH USE OF DISTINCTIVE FEATURES OF PHASE HOLOGRAMS

Frunze IZVESTIYA AKADEMII NAUK KIRGIZSKOY SSR in Russian No 2, 1980 pp 30-33

[Article by A. A. Akayev and M. A. Shabdanov, Frunze Computer Institute]

[Excerpt] Further increase of computer capacities gives rise to a need to develop ways and means for parallel data processing. Digital optical data processing is very well adapted precisely for parallel processing, because of the two-dimensional structure of the luminous flux that carries information.

Investigated in the present article are the functional possibilities of a holographic immediate-access memory [GOZY--golograficheskoye operativnoye zapominayushchoye ustroystvo] with page organization and an addressable beam [1], in which an information carrier is used which permits recording and storing information in the form of phase holograms. A distinctive feature of the given approach in the practical realization of method of parallel data processing by optical equipment consists in the use of distinctive features of the registering media with phase modulation and the execution of the principal logical operations in the medium itself through the superposition of page-operand holograms during recording.

The possibility of performing a logical operation through the superposition of holograms was revealed for the first time in [2], in which an investigation was made of the coherent selective erasure of superposed volume phase holograms recorded in an electro-optical crystal of lithium niobate $LiNbO_3$. The authors of that work noted the equivalence of that operation to the logical operation "MODULO 2 ADDITION." In [3] that idea is developed and the possibility of performing other basic logical operations is pointed out. Ways to carry out arithmetic operations have not been completely investigated, as far as the authors know.

We will show at the start analytically that in a GOZU with page organization on phase holograms it is possible to organize the performance of a functionally complete set of logical operations by superposition of the

page-operands themselves, and also of their holograms. Additional equipment for modulation of the phase of an information beam is used for the performance of logical operations in a GOZU, and a second device for page composition.

The accomplishment of logical and arithmetic operations is possible in a GOZU, and this permits using it not only to store data but also to solve problems in the simulation of discrete devices, the processing of frames of images and other tasks requiring the processing of page-organized data.

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[26-2174]

2174
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UDC 681.324.012

ESTIMATING MEAN WAITING TIME IN SPECIALIZED MULTIPROCESSOR COMPUTING SYSTEMS

Kiev KIBERNETIKA in Russian No 4, 1980 signed to press 12 Aug 80 pp 126-128

[Article by Vyacheslav Petrovich Koryachko, candidate of technical sciences, and deputy director of the SKB MMS [Special Design Bureau for Mathematical Machines and Systems], Institute of Cybernetics, UkSSR Academy of Sciences; and Nikolay Aleksandrovich Smolyarov, engineer, Ryazanskiy Radioengineering Institute. This article was received by the editors on 1 Nov 77.]

[Excerpt] In recent years, there has been a tendency to build specialized multiprocessor computing systems (SMVS) aimed at solving a certain class of problems in real time. This is due to SMVS's, problem-oriented to solving a given class of problems, providing higher throughput and reliability of information processing compared to general purpose systems.

A little studied problem associated with the features of operation of SMVS's is analysis of throughput losses due to the presence of conflict situations in the SMVS [1]. Conflict situations arise as a result of simultaneous accessing of a section of common memory (main or read-only) by several processors.

This work is aimed at analyzing conflict situations in SMVS's and determining the probability of conflicts when solving a given class of problems and the mean waiting time (dead time of processors in the SMVS) associated with resolution of them.

[47-8545]

8545
CSO: 1863

ON A DATA TRANSMISSION SYSTEM AS AN ADAPTIVELY CONTROLLED PROCESS

Budapest PROBLEMS OF CONTROL AND INFORMATION THEORY in English No 4, 1980 pp 1-12

[Article by V. N. Dyn'kin, S. I. Zhegalov, N. S. Raybman, and V. N. Starodubtsev]

[Excerpts]

1. Introduction. Problem Statement

The data transmission system (DTS) is a major element in a control system and its characteristics is a major component in the overall performance of the control loop. For these purposes DTS are described in terms of the probability that a certain amount of data will be transmitted within specified time and with the desired accuracy. These quantities are functions of system parameters such as channel capacity noise immunity, and of parameters of noise sources in the channels; they are interrelated as described in the fundamental Shannon theorem.

The possibility of transmitting data along a channel at a certain rate is not a sufficient condition for a system to perform its functions because the probability of error in actual communication channels is far in excess of the value admissible for most control systems. For this reason a DTS where accuracy is not improved by noise protection is a very rare case: the information features significant redundancy which permits error correction. The choice of code protection is, however, complicated by the fact that an optimal system should cope with error flux in the communication channel which at large intervals is, as a rule, non-stationary because of numerous disturbance whose parameters change randomly (the noise sources may be power cables, atmospheric phenomena, other channels, etc.). Even for a stationary channel the sequence of errors is described in a model with a discrete set of states, each associated with its source [1].

In designing a DTS for effective use of codes and for making the code protection able to withstand the error flux, first the error distribution is determined, the class of codes is chosen to cope with generalized parameters and then a more accurate model helps to find a most suitable code in that class.

This is not the best posssible approach because the disturbances are nonstationary. The available error protection systems essentially tune to the averaged error flux whereas in real life there are different channel states in which the error density varies within two or three orders of magnitude [2, 3]. Consequently, in some states the code protection (CP) is unduly high and in others insufficient; to put

it differently, in some cases the channel capacity is not used to the full and in other cases it is too high, which leads to low accuracy of the data. What is needed is a CP which would follow up the channel state so as to maximize the transmission rate (with the desired credulity maintained) over the entire transmission time except the intervals of failed state and adaptation periods of the channel. Also, while the failure duration is caused by inadequately low channel levels or powerful noises the duration of the adaptation period depends on the number of DTS states and the system response to their change.

On the other hand, the need in adaptive control of DTS is dictated by the replacement of rented channels by transmission through a commutative communication network whereby the transmission proceeds through changing channels of different length and performance and, generally, of different physical natures, cables, radio relays, satellites, etc. Indeed [1], the statistics of errors in these channels vary widely as do the lengths and itineraries which depend on the state and load of network parts. If the capacity of the transmitter accumulator does not adapt to the channel length, then its fixation to a maximal value and transmission along the surface line may almost half the throughput.

This leads to the conclusion that coding, algorithmical, and rate adaptation in a commutable network should be supplemented with adaptive change of the accumulator capacity. Construction of a unified automated communication network in the USSR makes adaptation of the DTS to transmission condition still more urgent.

Use of adaptive methods in data transmission in choosing an optimal data transmission system generally presumes knowledge of error distribution in time. This can be found if the sequence of signals is known in advance or changes by a rule known in advance, or proceeds in intervals when the system does not transmit working information.

Adaptive systems have been suggested where indirect methods are to be used for estimating the stages of a discrete channel from the number of reenquires [2]. These, however, help estimate, to some extent, the frequencies of block faults than distribution of errors, with the state estimate being significantly dependent on the encoding system.

Furthermore, there is a relation of the error rate in a discrete channel and noises in a continuous channel [2, 3]; in other words, parameters of disturbances in the continuous channel may give an indirect indication of the performance of the discrete channel and thus help change the transmission system.

For long periods a white noise of relatively small magnitude is present in the channel and during these the transmission can proceed at a near-throughput rate. Because of the fluctuating nature of the noise errors arise independently and relatively rarely: the coding system can correct errors of low magnitude and detect those of higher magnitude. A system with resolving feedback and a single error-correcting code (code with distance $d = 4$) and detecting about half of the errors of higher magnitude.

Occurrence of noises above a level at which the error frequency exceeds a value admissible for a system which corrects a single error and detects errors of higher magnitude will be a signal for the decoder to switch from correction with subsequent detection to detection. With further increase of the noise level both the encoder and the decoder should be readjusted in order to increase redundancy or reduce the coding rate. Express analysis methods are quite sufficient for determining the current channel state.

Note that in transmission along commutable channels monitoring of the signal-to-noise ratio should be supplemented with measurement of the jitter which significantly affects noise immunity of phase modulation systems which operate at a high specific rate.

Consequently, adaptive DTS can be designed as is done for industrial processes [4].

The block diagram of such a system (Fig. 1) includes an identifier I of the channel state and a control unit CU which readjusts the encoder and the decoder in response to identifier signals. The current channel state is thus determined by an element new in a DTS, an identifier which can be a software or a hardware tool. In analogy with adaptive ones in process control including an identifier in the control loop will be referred to as ASI.

The discussion below will concentrate on ways of data transmission feasible in ASI DTS.

4. Conclusion

The paper has discussed an essentially new system of data transmission in which the *ASI* methods are extended to the theory and applications of information transmission. Possible ways have been shown to implement the methods for two data transmission techniques with error detection, two-way block transmission with interlocking and one way by convolution codes. As far as high transmission rates are concerned convolution codes are preferable because they permit reducing the amount of information to be retested in error detection.

It is intuitively clear that this adaptive approach to *DTS* design can be technically and economically effective. The final word is, however, to follow from tests in real systems. These will be discussed in our subsequent paper. Let us only note that in some kinds of channels the methods help improve the transmission rate by about six per cent while maintaining the desired information credibility.

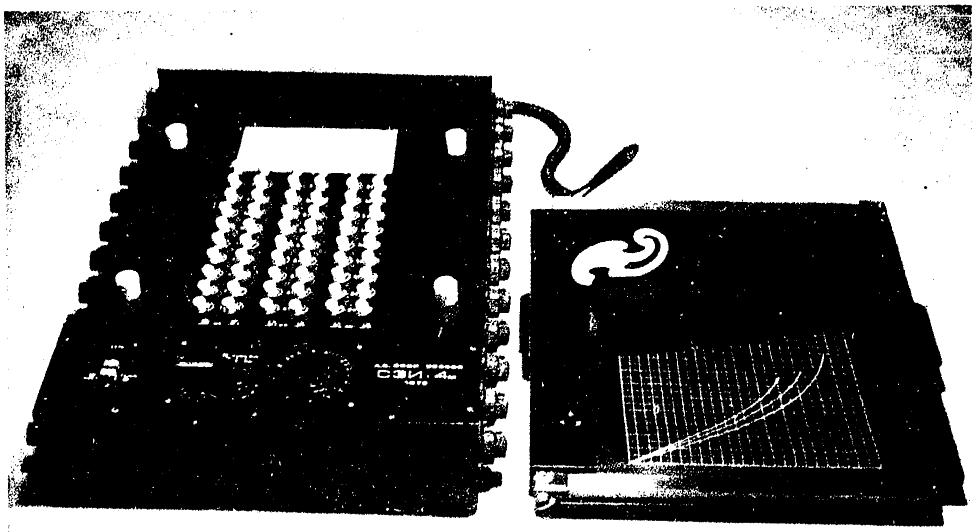
[901-E]

CSO: 1863

ELECTRONIC ANALYZER SEI-4M

Kiev ELEKTRONNOYE MODELIROVANIYE in Russian No 4, 1980 p 2

[Text]



SEI-4M miniature steady-state electronic integrator developed in the mathematical modeling problems laboratory of Kazakh State University and designed for solving linear and nonlinear ordinary differential equations and partial differential equations of mathematical and technical physics

8831
CSO: 1863

UDC 621.317.7.085.36

F-4241 DIGITAL-ANALOG CONVERTER

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, 1980 p 26

[Announcement]

[Text] The instrument is designed for the conversion of coded digital signals and direct voltage in information-measuring systems, telemechanical systems and automatic centralized monitoring and control of productive and technological processes.

The input signal code is a binary normal parallel 12-digit one, including polarity discharge. The range of output signal measurements is from +5 to -5 V. The maximum conversion time is 8 microseconds. The precision class is 0.2/0.15. The basic allowable relative error δ in percentages of the measured amount does not exceed the values determined with the formula $\delta = \pm [0.2 + 0.15 (X_{fin}/X - 1)]$, where X is the current and X_{fin} is the final value of the working range of measurements. The input signals have values of -0.4 to +0.8 for "0" and +2 to +5.25 V for "1". The coded signals correspond to "1" positive and "0" negative polarities of the input coded signal. The power voltage is $\pm$15 $\pm$0.15 and +5 $\pm$0.25 V at maximum currents of 120 and 350 MA respectively. The power consumption is a maximum of 5.5 W. The dimensions are 40 x 156 x 126 mm. It mass is a maximum of 600 g.

The instrument is produced by the "Elektropribor" Production Association in Kiev.

[55-2174]

2174
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PROCEDURE FOR DETERMINING THE BASIC PARAMETERS OF A SPECIALIZED DIGITAL COMPUTER IN THE SYSTEM DESIGNING STAGE

Kiev ELEKTRONNOYE MODELIROVANIYE in Russian No 2, 1980 pp 25-28

[Article by A. M. Belevtsev, V. F. Guzik, and A. I. Piterskiy]

[Text] At the present time in the creation of specialized digital computers the stage of system designing is the most complex. This is caused by difficulties arising during formalization of the description of the process of designing specialized computers by means of a general purpose computer.

The purpose of the present article is to develop a procedure for determining the basic parameters of specialized computers:

--an optimum order set
--optimum technical characteristics of specialized computers in the sense of the criterion

$$W_{opt} = \min_{j \in M} \{Q'_{Алу} + Q'_{пзу} + Q'_{уу}\} \qquad (1)$$

at the given limitations $\sigma_{\Sigma j} \leqslant (\sigma_{\Sigma})_{ТЗ}$, $T_j \leqslant (T)_{ТЗ}$. Here $Q'_{Алу}$, $Q'_{пзу}$, $Q'_{уу}$ are the equipment expenditures on realization of arithmetic-logical, permanent storage and control devices; $\sigma_{\Sigma j}$, $(\sigma_{\Sigma})_{ТЗ}$ are the instrumental and methodical errors of the specialized computer being designed for the technical task (ТЗ) and the j-th variant of realization; T_j and $(T)_{ТЗ}$ are the times required for realization of the algorithm of the task solved in the specialized computer for the j-th variant and the technical task; M is the set of variants under consideration.

Formulation of the problem and starting data for specialized computer designing

The criterion of designing of a specialized computer for solving a given fixed problem can be formulated as follows. If we have the starting data it is necessary to determine in some way a specialised digital computer order set which would assure the solution of the problem in the presence of all limitations (1) and would optimally combine the program and apparatus methods of algorithm realization. Solution of the given problem leads in the final account to minimization of specialized digital computer equipment expenditures W.

The starting data for the specialized digital computer planning or, if it was already formulated, for determination of the specialized computer order set are:

A -- an algorithm for problem solving on the specialized digital computer;

$(T)_{ТЗ}$, $(\sigma_\Sigma)_{ТЗ}$ -- times required for realization of algorithm A, which are the summary instrumental and methodical errors;

$\{O_\eta\}_{\eta=1}^{n}$ -- the set of functions and operations entering the description of the task.

The main specialized digital computer parameters include:

$\{O_\eta^*\}_{\eta=1}^{k}$ -- the set of computer operations realizing A;

d -- the permanent store volume for realization of algorithm A;

C -- the microprogrammed control device storage volume for realization of the set $\{O_\eta^*\}$ according to the microprograms $\{H_z(O_z)\}$, $Z=\overline{1,l}$, $l\leqslant k$;

t_Σ, $t_{УМН}$, etc -- the times required for operations;

σ_M, σ_M -- the instrument and methodical errors in the realization of A;

N -- the digit capacity of the registers;

R -- the arithmetic-logical device summator.

The initial algorithm A can be divided into the elementary sections A_i, each of which is characterized by a cortege set [1]. The cortege set includes the above-defined specialized digital computer parameters. If A_i is a functional transformation, elementary in the usual mathematical sense, for example, $\int(\ )d(\ )$, $\sin(x)$, $\operatorname{tg}(x)$, $\arccos(x)$, x^r, etc, then section A_i can be realized by one operation $O_i\in\{O_\eta\}$ or group of simpler operations (the function sin (x) can be reproduced either by integration of differential equations or by calculation of the sum of a Taylor series), which, depending on the complexity and numerical method of calculation, form the series

$$\tilde{E}=O_i,\ \left\{\bigcup_{j=1}^{n1}O_j\right\},\ \left\{\bigcup_{j=1}^{n1}O_j\right\},\ \ldots,\ \left\{\bigcup_{j=1}^{nm}O_j\right\}.$$

Corresponding to each member of the $\tilde{E}$ series is a set of operations from $\{O_\eta^*\}_{\eta=1}$, which can contain one or several computer operations $O_{\eta_1}^*$ and also the set of microprograms $\{H_z(O_z)\}$. The range of numerical methods taken into account must be limited in such case.

If A_i is a certain operation of the type c*d, then A_i corresponds to the operation O_{η_1}, which in a specialized digital computer is realized either structurally or according to the microprogram $H_{\eta_1}(O_{\eta_1})$ for the operation O_{η_1}.

Cortege sets for all elementary sections A_i form a set of realizations Ψ for algorithms A, that is, $\Psi=\{\Psi_1, \Psi_2, \ldots, \Psi_p\}$, where Ψ_1 is the cortege set or realization of section A_i. Then σ_{Σ_j} and R_j are determined by the procedure given in [2], where $j\in M=\{1,2,\ldots,p\}$ is the specialized digital computer variant under consideration. Then fulfilment of the condition $\sigma_{\Sigma_j}\leqslant(\sigma_\Sigma)_{ТЗ}$ is verified and a calculation is made of the series of metrics $\rho_j(\sigma_{\Sigma_j}, (\sigma_\Sigma)_{ТЗ})$, which are arranged in order of decrease.

For different variants of the realization of A a calculation is made of the equipment of the permanent storage volume d_j and the volume of storage of the microprogrammed control device $y\gamma - C_j$ for a certain selective addressing system. Then for each j-th variant there is a corresponding set of operations $\{O'_n\}$, for the accomplishment of which the specialized digital computer has an order set $\{O''_n\}$ and a microprogram set $\{H_{\lambda}(O_j)\}$.

In the selection of formats of orders and microorders for each j-th variant an estimate is made of the equipment expenditures $(O'_{n3\gamma} + O'_{\gamma y})$. When the addressing changes that estimate is recalculated. The obtained estimates for all the various alternatives are arranged in the form of a series, after which $\min_j (O'_{n3\gamma} + O'_{\gamma y})$ is determined.

To determine σ_{Σ_j} and R_j more precisely, algorithm A is simulated. When necessary the values of R_j are corrected or a transition is made to an alternative with a larger metric $\rho_k > \rho_j$, in which case $\rho_k = \min_{j \in M, i \neq j} (\rho_i)_{i=1}^{M}$, for which the above-described series of calculation stages is repeated. In the concluding stage of the times required for performance of operations $\{O''_n\}$ of the j-th and k-th alternatives, provided that $T_j \leqslant (T)_{T3}$, $T_k \leqslant (T)_{T3}$, and the values of R and N are determined (the digit capacities of the registers and the arithmetic-logical device summator), optimal in the sense of $\min_j Q'_{\lambda n \gamma}$.

Such a procedure reflects in principle all the basic stages in specialized digital computer development, besides the stage of construction of an optimum order set [3]. At the present time there is only one way to select a specialized digital computer order set, which consists in the simulation on a general purpose digital computer, with subsequent correction until satisfactory characteristics are obtained for the specialized digital computer order set [4].

Determination of an order set with a Shannon scheme

The basic idea regarding the selection of a specialized digital computer order set consists in the following. It is known that in the class of Shannon schemes or in the class of T-operators [5,6] for a given group of tasks an operator basis is constructed, the elements of which (the basal operators) can be realized by a structural method in specialized parallel computer structures [7]. Functional completeness of the computer equipment in the given class of problems is achieved at the same time. On the basis of the given method it is proposed to represent the starting task or an algorithm for its realization in a specialized digital computer in the class of Shannon schemes. After such a representation, in accordance with a special algorithm the basal set of operators is determined [6], by means of which the initial algorithm can be realized. Then, using the described states, it can be determined which elementary sections of algorithm A can be realized structurally by means of a Shannon scheme (numerical integration according to Stieltjes), and which sections can be realized by point methods structurally or by microprograms. After selection of algorithm A sections realizable by point methods a correction of the basal set is made which consists in the following. Each T-operator represents a multiple-valued representation of the type $T: f(x) \rightarrow E_{f(x)}$, where $E_{f(x)}$ is the set of solutions of the system of Shannon differential equations for the functions $f(x) \in C^{n}[a, b]$, $f(x)$ is the main value of the operator, $E'_{f(x)} = E_{f(x)} / \{f(x)\}$ is the set of similar functions. If there is a basis of operators $B = \{T_1, T_2, \ldots, T_k\}$ by means of which is generated the system of functions and operations $S = \{f_1(x), f_2(x), \ldots,$

$f_n(x), g_1(x, y), g_2(x, y), \ldots, g_n(x, y)\}$, where $f_i(x)$ is a function of the argument x; $g_j(x, y)$ is the operation from the operands x, y; m $\geqslant$ k , then removal from the basis of the operator T_j causes the appearance in S of functions or operations which previously were generated by T_j and now are not generated by the remaining operators. Consequently, it is necessary to include in S the set $E_j^* \subset E'_j$ or the entire set of similar values E_j of the operator T_j, if they are used in the algorithm, and the basis B is again selected.

The algorithm for construction of the basis in the class of Shannon schemes can be formulated in the following manner. Let the system of functions S = $\{f_i(x)\}_{i=1}^{k}$, $S \subset C^1[a, b]\}$ entering the mathematical description of a task solvable on a specialized digital computer, be given. Then we have the following.

1. For $S = \{f_i(x)\}_{i=1}^{k}$ we assume that i = 1, that is, we select the function f_1.

2. Let us define E_1 as $T_{f_1} \rightarrow E_1 = \{f_1\} \cup E'_1$, where $E'_1 = \{f_\alpha\}$ is a certain subset of functions $f_\alpha \in C^1[a, b]$; in the general case there is $f_\alpha \not\subset S$ in E'_1.

3. Let us construct the set $P^1 = S \setminus E_1$ as $P^1 = \{f_i \mid f_i \not\subset E_1, f_i \in S\}$.

4. If P' = $\emptyset$, then E_1 is the prototype of the operator basis B in the functional space $C^1[a, b]$; consequently $B = \{T_{f_i}\}$.

5. The inequality P' $\neq \emptyset$ testifies that in S there are functions for which in B there are no T-operators.

6. For $S = \{f_i(x)\}_{i=1}^{k}$ we assume that i = 2, that is, we select the function f_2.

7. Let us define E_2 as $T_{f_2} \rightarrow E_2 = \{f_2\} \cup E'_2$, where $E'_2 = \{f_\beta\}$ is the subset of functions f_β, analogous to E'_1.

8. Let us construct the set $P^2 = S \setminus E_2$ as $P^2 = \{f_i \mid f_i \not\subset E_2, f_i \in S\}$.

9. If $P^2 = \emptyset$, then E_2 is the prototype of basis B; consequently, $B = \{T_{f_i}\}$.

10. Let us construct the set $P = S \setminus E$, where E is defined as $T_{f_i} \oplus T_{f_i} \rightarrow E = E_1 \cup E_2$.

11. If P = $\emptyset$, then E is the prototype of the basis in $C^1[a, b]$; consequently, $B = \{T_{f_i}, T_{f_i}\}$, otherwise, the following point.

12. $\vdots$ N.

Consequently, $B = \{T_{f_\gamma}\}_{\gamma=1}^{n}$, where $n \leqslant k$.

Here it is necessary to examine the resulting set $E_\gamma = \bigcup_{\gamma=1}^{n} E_{f_\gamma}$ in comparison with the system S.

If $H = E_\gamma \setminus S \neq \varnothing$, i. e. $H = \{f_j \mid f_j \in E_\gamma$, then the basis $B = \{T_{f_\gamma}\}_{\gamma=1}^{n}$ outside the system S can generate a certain system S', where $|S'| > |S|$. Following reference [6], such bases are called open for S and the system S is also open for B, that is, $\exists f \exists g (f \in S, g \in E_f, T_f \rightarrow E_f) \Rightarrow (g \not\subset S)$.

If $H = E_y \setminus S = \varnothing$, then B completely determines S and is called a closed basis of system S, and the system also is closed in relation to B, that is, $\forall f (f \in S, T_f \to E_f) \Rightarrow (E_f \subseteq S)$.

In addition, further optimization of the basis in order to reduce the number of terms in basis B is possible.

The process of correction of the basal set for realization by continuous and point methods is concluded when algorithm A is optimally divided according to some criterion.

Besides the correction made on the basis B to satisfy the main requirements for specialized digital computers with regard to precision and speed, it is necessary to obtain a set of possible realizations of algorithm A in the form of the series E_i and $i \in M$ by means of T-operators and a group of mathematical operations $\{O_n\}$ and also a set of complete realizations, corresponding to those series, by continuous structural methods for T-operators (numerical integration), point structural or apparatus methods (a set of computer operations $\{O_n^*\}$) and program methods (a set of microprograms $H_z(O_z)$).

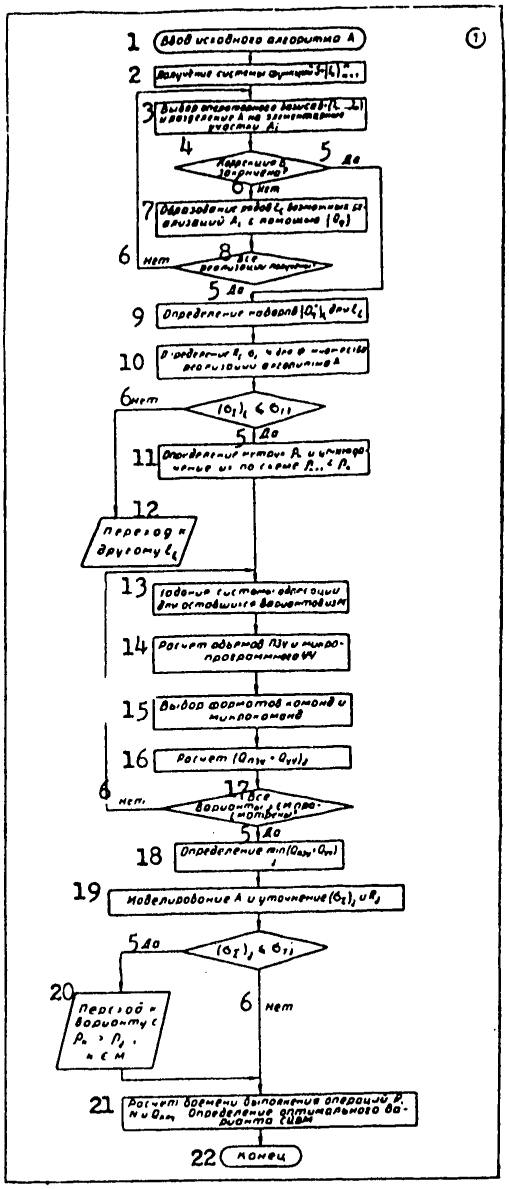
After the given stage an estimate is made of the set Ψ of realizations of algorithm A with subsequent selection of the optimum alternative. Figure 1 presents a block diagram of the algorithm for selection of an optimum alternative of a specialized digital computer. For completeness of the account, it must be noted that orders for control transfer of the types of "conditional transfer" and "unconditional transfer" and logical operations on operands can in principle be presented in the form of Shannon schemes and realized by means of functions of sign (sign(x)) and limitation ($\sigma(x)$). However, it would be advisable to make it possible for the designer himself to solve the question of the quantity and need for orders for transfer of control and logical operations to a specialized digital computer, starting from analysis of the algorithm.

Thus the use of Shannon schemes permits:

-- writing an algorithm for the specialized digital computer solution of a task in terms of operators regardless of the method of realization;

-- without simulating the order set, selecting in accordance with given criteria the set Ψ of suitable realizations of the specialized digital computer algorithm by using a procedure for designing an operator basis;

-- by starting from the global optimization criterion $W_{opt}(1)$, selecting from Ψ the optimum specialized digital computer alternative.



Block diagram of algorithm for determining specialized digital computer basic parameters

1 -- Input of initial algorithm A
2 -- Obtaining the system of functions $S = \{f_k\}_{k=1}^{n}$
3 -- Selection of operator basis $B = (T_1, \ldots, T_n)$
4 -- Has correction of B been completed?
5 -- Yes
6 -- No
7 -- Formation of series E of possible realizations of A_i by means of $\{O_\eta\}$
8 -- Have all realizations been obtained?
9 -- Determination of sets $\{Q_\zeta^*\}$ for E_ζ
10 -- Determination of R_j, σ_j and N for ψ set of realization of algorithm A
11 -- Determination of the metrics P and their ordering according to the scheme $\rho_{k+1} < \rho_k$
12 -- Transition to another E_ζ
13 -- Assignment of system of addressing for remaining alternatives of M
14 -- Calculation of volume of permanent storage and microprogram storage
15 -- Selection of formats of orders and microorders
16 -- Calculation of $(Q_{\text{пзу}} + Q_{\text{уу}})$
17 -- Have all the $i \in M$ alternatives been examined?
18 -- Determination of $\min_j(Q_{\text{пзу}}, Q_{\text{уу}})$
19 -- Simulation of A and more precise determination of $(\sigma_\Sigma)_j$ and R_j
20 -- Transition to variant with $P_k > P$, to $\in$ M
21 -- Calculation of time required for performance of operations R, N and $Q_{\text{ПЛУ}}$. Determination of optimum specialized digital computer alternative
22 -- End

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SOFTWARE

ABSTRACTS FROM THE JOURNAL 'PROGRAMMING'

Moscow PROGRAMMIROVANIYE in Russian No 5, 1980 pp 95-96

UDC 681.3.323

SUBSTANTIATION OF TRANSFORMATION OF CYCLE CLEARING

[Abstract of article by Pommosin, I. V., and Yugrinova, O. V.]

[Text] For a model of linear circuits contextual conditions are derived for removing a statement both before and after an m-dimensional circuit (cycle). The article investigates the mutual influences of transformations to remove statements and gives two algorithms which have the greatest clearing impact (for different classes of circuits) for the model under study and without taking consolidation of statements into account.

UDC 681.142.2

AN APPROACH TO CONSTRUCTING A UNIVERSAL LANGUAGE CIRCUIT. SYNTAX

[Abstract of article by Tuzov, V. A.]

[Text] This article presents one version of a universal language circuit, which can be used for an exact description of both languages and algorithms. The essential features of the circuit are shown by example.

UDC 681.3.06.51

RECOGNITION ALGORITHM FOR ONE CLASS OF QUASIRECURSIVE-TYPE PARAMETRIC GRAMMARS

[Abstract of article by Yevladenko, V. N.]

[Text] One of the supraclasses of quasirecursive-type parametric grammars is identified and a description of an effective algorithm for syntactical control is given for this class.

UDC 681.3.06

GENERALIZED ARRANGEMENT FUNCTION AND THE ORGANIZATION OF FILES WITH RANDOMIZED STRUCTURE

[Abstract of article by Litvinov, V. A., and Ivanenko, V. I.]

[Text] This article reviews the problem of selecting a randomization function. It describes a technique for formulating a generalized arrangement function in terms of monitoring theory based on redundant coding of requisites.

UDC 519.68

FUNCTIONAL-OPERATOR MULTIPROCESSOR AND THE PROBLEM OF BREAKING ALGORITHMS INTO PARALLEL PARTS

[Abstract of article by Glivenko, Ye. V., Zhukova, T. M., and Shevchenko, S. V.]

[Text] This article considers the special features of programming for functional-operator computers. An argument is presented for the effectiveness of these computers in solving a broad range of problems. The comparative simplicity of breaking algorithms into parallel parts is demonstrated.

UDC 519.685.3

METHODS OF REALIZING ATTIRBUTE CIRCUITS IN SYSTEMS FOR CONSTRUCTING TRANSLATORS

[Abstract of article by Merisme, M. B.]

[Text] This article is a survey of various algorithms for computing attributes. The algorithms reviewed are ones used to realize the attribute method of describing the semantics of programming languages.

UDC 681.32.06:801.3

AUTOMATIC CLASSIFICATION OF CONCEPTS IN NORMALIZED SCIENTIFIC-TECHNICAL TEXTS

[Abstract of article by Lakhno, T. N.]

[Text] This article considers an algorithm for constructing a classification model of a thematic range of objects based on analysis of normalized texts of documents.

UDC 681.3.06

STRUCTURAL INTERPRETATION OF INFORMATION-LOGICAL PROGRAMMING LANGUAGES

[Abstract of article by Vidomenko, V. P.]

[Text] This article investigates the operational complement of the programming level of the internal language of a hypothetical computer whose input language is oriented to solving information-logical problems.

UDC 681.326.06

EVALUATING THE QUALITY OF REALIZATION OF LINGUISTIC STRUCTURES IN TRANSLATORS

[Abstract of article by Vasyuchkova, T. S.]

[Text] The author presents the Wichman [Uichman] method of evaluating the quality of the object code of a translator and gives a detailed description of an experiment run at the Computing Center of the Siberian Department of the Academy of Sciences USSR on measuring four translators for the BESM-6.

UDC 519.95

DEVELOPMENT OF ALGORITHMS FOR MODELING A GLOBAL EPIDEMIOLOGICAL PROCESS OF MUTANT ORIGIN

[Abstract of article by Baroyan, O. V., Mironov, G. A., and Rvachev, L. A.]

[Text] The article presents a generalized model of an epidemic process figured for rapidly spreading microorganisms with previously unknown parameters (flu and other mutants). The possibility of realizing an appropriate global algorithm on the computer is demonstrated and a general estimate of its software and the required computer productivity is given.

UDC 681.3.06

THE SIMPLEST STRATEGY FOR ORGANIZING PARALLEL COMPUTATIONS IN A MULTIMACHINE HEIRARCHICAL SYSTEM WITH MODULAR PROGRAMMING

[Abstract of article by Gorskiy, V. Ye., and Kichanov, M. V.]

[Text] The simplest strategy for organizing computations in multimachine heirarchical systems with modular packaging of the programs is described. The strategy makes it possible to realize an effective planner.

UDC 681.3.06

MEANS FOR PERFORMING THE SERVICE PROCEDURES OF THE YES COMPUTER OPERATIONS SYSTEM FROM THE OPERATOR'S CONSOLE

[Abstract of article by Agamirzyan, I. R.]

[Text] This article reviews the UNIVCALL service system, which is designed to perform the service (utility) programs of the YeS Computer operations system from the operator's console. Examples are given of catalogued procedures that use this program and make it possible to manipulate arrays of data and volumes within the YeS operations system without preparing package structures.

UDC 681.3.06

PROGRAM CONTROL OF MEMORY DISTRIBUTION IN FORTRAN

[Abstract of article by Kurbatov, A. V., and Lazarev, M. I.]

[Text] This article presents a design of standard Fortran statements that permits dynamic allocation of memory in arrays during performance of a program. The characteristics of translating subroutines in the YeS operations system and the disc operations system are used.

UDC 681.3.06

MAUS -- A PACKAGE OF PROGRAMS FOR PROCESSING ACCOUNTING DATA ON COMPUTER WORK

[Abstract of article by Treymanis, M. O.]

[Text] A description is given of a package of programs that provides for processing and long-term storage of various types of accounting information on the work of up to 10 YeS computers. The accounting data, represented operationally in the form of tabulations, can be used for commercial accounts between customers and a computing center. It reflects usage of various computer equipment.

[59-11176]

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CSO: 1863

DOCUMENTATION FOR APPLIED PROGRAM PACKAGES TO BE PUBLISHED

Moscow NAUCHNO-TEKHNICHESKAYA INFORMATSIYA, SERIYA 2 in Russian No 4, 1980 pp 16, 30

[Text] In 1980 the International Center for Scientific and Technical Information [MTsNTI] will publish issues in the series "Metodicheskiye materialy i dokumentatsiya po paketam prikladnykh programm" [Methodological Materials and Documentation for Applied Program Packages].

The series includes the following issues: "Primeneniye sistemy teleupravleniya KAMA v avtomatizirovannykh sistemakh NTI" [Utilization of the KAMA Telecontrol System for Automated Scientific and Technical Information Systems]

The experience of the MTsNTI is described in employing the KAMA system as a communication monitor for applied problems of teleprocessing scientific and technical information. Methodological questions of elaborating applied programs, the system's language facilities, and methods of problem debugging and testing are examined. The organization involved in elaborating large systems is examined on the example of a dialog system for automating linguistic operations.

Estimated price of issue R 2.00
NK [Noviye knigi] 39/79, item 142

"Primeneniye tekhnicheskikh sredstv YeS EVM v sistemakh teleobrabotki nauchno-tekhnicheskoi informatsii" [Application of Hardware of a Unified System of Electronic Computers for Scientific and Technical Information Teleprocessing Systems]

MTsNTI experience is described in applying the EC-8403 multiplexer, the EC-8564 and EC-9570 terminals, EC-8002 and EC-8006 modems, and Videoton-340 and DZM-180 input-output units for a scientific and technical information teleprocessing system.

Questions are examined of coupling and debugging units in off-line and systems operation for asynchronous data transmission at a rate of 100 to 1,200 bauds over switched and leased telephone lines.

Estimated price of issue R 1.40
NK 39/79, item 143

"Dialogovaya sistems avtomatizatsii lingvisticheskikh rabot DIALIN" [The DIALIN Dialog System for Automating Linguistic Operations

The structure and functional possibilities are described of the DIALIN package of applied programs which makes it possible to automate work with dictionaries, index terms of documents and requests. DIALIN is employed on EC-7906 and EC-8564 displays and controlled by the KAMA system.

Estimated price of issue R 2.00
NK 39/79, item 140

"Primeneniye sistemy translyatsii baz dannykh (TRANSBAD)" [Employing the TRANSBAD Base Data Translation System]

Problems of data reorganization that arise in conjugating different types of information systems are examined. Data translation languages making it possible to determine generalized specifications of data translator programs are described. The TRANSBAD base data translation system developed by MTsNTI and the experience of its application is described.

Estimated price of issue R 2.00
NK 39/79, item 144

"Standarty i rekomendatsii v oblasti programmnogo obespecheniya sistem teleobrabotki (spravochnik)" [Software Standards and Recommendations for Teleprocessing Systems (a Handbook)]

Information on teleprocessing standards and recommendations is classified according to subject matter.

The handbook covers standards and recommendations of member nations of the MTsNTI, ISO, CCITT, and other international organizations.

Estimated price of issue R 0.60
NK 39/79, item 145

"Pakety prikladnykh programm dlya teleobrabotki nauchno-tekhnicheskoi informatsii" [Applied Program Packages for Teleprocessing Scientific and Technical Information]

The use is described of applied programs within the DIALOG system for remote search for scientific and technical data. Teleprocessing modes involving the use of EC-8570, EC-8564 and EC-7906 units and telephone communication lines are examined. Methodological recommendations are offered on the organization of a network of long-distance access to base data, and the functions of telecontrol and terminal operators are described.

Estimated price of issue R 2.00
NK 39/79, item 141

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UDC 51:681.3.06

PARALLEL LANGUAGES

Kiev KIBERNETIKA in Russian No 4, 1980 signed to press 12 Aug 80 pp 1-10

[Article by Vadim Yevgen'yevich Kotov, candidate of physical and mathematical sciences, and deputy director of the Computational Center of the Siberian Branch of the USSR Academy of Sciences, Novosibirsk. This is part two of the article; part one was published in KIBERNETIKA, No 3, 1980. This article was received by the editors on 27 Nov 79.]

[Excerpts] 4. Conclusion

An attempt was made in this work to answer the question of what the parallel programming languages of the next generation should be. A history of the penetration into languages of the descriptive and assignment facilities for parallelism was traced briefly. The process was evolutionary and followed the evolution of both computers and the methods and spheres of their application. The most progress was in organizing control of serial processes flowing in parallel, since this is precisely the type of parallelism characteristic of multiprogramming systems. But at the same time, studies of these problems have shown how much more complicated programming of parallel processes is than serial programming. Attempts to simplify it by raising the level of abstraction of control primitives lead to loss of efficiency (and still do not improve the error rate). Therefore we suggest a concept of families of compatible parallel languages containing control facilities and "control structure spaces" adequate for the various regions. Compatibility is expressed in the same parallel computation control method--the method of descent functions--being the basis of all control mechanisms. This is possible because all other parallel computation organization methods may be considered particular cases. Among them: serial-parallel organization of processes, mechanism of synchronous vector and matrix computations, flow control, non-procedural organization of high-level languages, etc. Incidentally, non-procedural and microprogramming languages have not been considered here, since this would have required expansion of the article and would have interfered with focusing on the main, basic level of parallel computation control structures.

As a whole, the introduction of parallelism into computations is an integral part of the overall process of improving computer programming languages and architecture. In the process, the evolution of languages will largely determine the architecture of future computers, since new principles of organization of computations materialize precisely in languages. The introduction of parallelism into programming languages, properly implemented, will not only not complicate programming, but on the

contrary, will promote development of such program qualities as modularity, high reliability and efficiency of programming, and high efficiency of program execution.

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[47-8545]

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UDC 518.74:681.3

PRESENTATION OF KNOWLEDGE AND FORMATION OF DECISIONS IN A PRACTICAL ARTIFICIAL INTELLIGENCE SYSTEM

Kiev KIBERNETIKA in Russian No 4, 1980 signed to press 12 Aug 80 pp 99-108

[Article by Aleksey Grigor'yevich Chachko, candidate of technical sciences, and senior scientific associate of the Institute of Automation, Kiev; and Tat'yana Mikhaylovna Stakhovaya, junior scientific associate of the Institute of Automation, Kiev. This article was received by the editors on 20 Dec 78.]

[Excerpts] The purpose of this work is to build a practical system for decision-making when controlling complex industrial processes. An example of such a process is generating electricity in thermal and atomic power stations.

ASU TP [automated systems for control of industrial processes] for these facilities are efficient in start-up and normal operating modes, but conditions with gross deviation from the norm have not yet been covered by automation. Meanwhile, it is precisely under these conditions that 75 percent of the operational mistakes are made and accidents occur, resulting in annual losses of 600,000 to 900,000 rubles per 1000 MW unit.

It is economically expedient to automate the search for causes of operational malfunctions and planning of corrective actions. Automation, however, is restrained by the lack of a mathematical description of the industrial processes.

It has been established [1] that for multiply connected dynamic systems, "precise" description of the processes, for example in the form of differential equations in partial derivatives, is inefficient for three basic reasons.

Operational decisions are formulated in the form of cause-effect graphs, the so-called industrial process situation evaluation trees (DTS).

The system described was installed on a BESM-4 for part of a power unit (regeneration circuit). The amount of memory occupied by the system is equal to 10,000 instructions.

The system in question is now an integral part of the ARGO [expansion unknown] system that is being developed for two principal applications: as a means of training operators for thermal or atomic power stations, and as an advisor to the operator who directly controls the power unit [8].

Training Mode. Used to train specialists to make operational decisions, particularly for rapid and efficient search for causes of deviations and irregularities.

The system offers the trainee technological substantiations for choosing specific causes; possibilities for adding causes and symptoms (incomplete trees are output on the display, the trainee makes an addition from the keyboard, the system checks the completeness and correctness of the additions); possibilities for constructing new trees with checking of correctness and explanation of errors; game possibilities, for example, a game for figuring out causes of a deviation selected by the machine, but unknown to the trainee, within a minimum number of moves.

Advisor Mode. Substantially improves a human operator's search for causes of a power unit deviating from normal operating conditions. This improvement is achieved primarily through efficient organization of the course of the search. System work results are reflected on a display in the form of a situation evaluation tree that allows an operator to judge the entire set of possible causes and their interrrelation.

Inasmuch as the characteristic symptoms (thermophysical parameters, status of controls, equipment status and others) are rigidly associated with causes, the advisor also selects out information, displaying from the entire set of symptoms only those pertinent to a given situation.

The volume of information selected by the system is not invariable. The human operator has the prerogative of deleting some tree branches as not pertinent to the situation or of adding new ones. In this case, the system analyzes the correctness of the change. A request to add symptoms or delete superfluous ones is also possible. A very substantial role is played by the so-called "noninstrument symptoms," i.e., equipment statuses that can be evaluated only by an inspector on the spot (noises, local damage, local switching, etc.). The system displays inquiries with indication of the names of instrument symptoms and the forms for inputting them into the computer. After refinement of the tree structure and input of the instrument and noninstrument symptoms, the system reduces the situation evaluation tree, narrowing the field of possible causes of the deviation to a few or even one.

Thus, the advisor to the operator makes it possible to find the cause of a deviation from the norm within a limited number of steps (3 to 12 for the various situations), after which it becomes possible to avoid development of an emergency situation and to return the power unit to normal operating conditions.

Speeding up the process of making operational decisions is also achieved through optimal presentation of information on the displays. For this purpose, a mnemonic language was developed for the operator to interact with the system; the same language is used in the training mode [9].

The ARGO system is being developed for the simulation and training center of the UkrSSR Minenergo [Ministry of Power and Electrification] (economic effect about 1 million rubles), and has also been included in the project of the Khmel'nitskaya AES (effect about 800,000 rubles). This system can also be applied in the chemical, petrochemical and continuous metallurgical industries to partially automate diagnostic processes and with some modification of the algorithm for predicting a situation.

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[47-8545]

8545
CSO: 1863

UDC 681.3

A FORMALIZED MODEL OF AN INTERACTIVE PROGRAM-HARDWARE SYSTEM

Kiev KIBERNETIKA in Russian No 4, 1980 signed to press 12 Aug 80 pp 35-40

[Article by Yevgeniy Anatol'yevich Alekseyenko, candidate of technical sciences, and senior scientific associate of the Institute of Cybernetics of the UkSSR Academy of Sciences, Kiev; and Aleksey Mikhaylovich Dovgyallo, candidate of technical sciences, and laboratory director, Institute of Cybernetics, UkSSR Academy of Sciences, Kiev. This article was received by the editors on 4 Aug 78.]

[Excerpts] 1. Introduction

The basic functional parts of an artificial decision system, "capable of interaction," were presented in work [1]; however, this system was not tied to real programs and hardware of modern computers, and its functioning and development were not defined. Let us call a decision system, functioning in some real operating and hardware environment of a concrete computer, an instrumental interactive program-hardware system (DPTS).

The generalized structure of the DPTS is given below and is based on development of the systemological approach applicable to the concept of interaction introduced in [1] and to the DPTS class referred to. According to the classification of systems suggested by V. V. Druzhinin and D. S. Kontorov [3] (pp 119-125), this DPTS should be a programmed cybernetic system with elements of self-learning and self-adaptation to the external environment.

The generalized structure of the DPTS shown in figure 2 was used when the training course programming system (SPOK) was created [8].

SPOK has now been implemented in more than 50 organizations in the country and on its basis there has been created a gamut of interactive courses for applications programs for the most varied purposes ranging, for example, from an English language course to one on training operators for the YeS OS [operating system of the unified system of computers].

As the industrial operating experience of SPOK shows, realization of the systemological approach ensured high reliability of the system, simplicity of "training" and development, and preservation of system integrity during malfunctions and hardware changes.

At the Institute of Cybernetics of the UkSSR Academy of Sciences, a version of SPOK was implemented that operates in the DOS YeS [disk operating system of the unified system of computers] envelope. The scientific research center of the "ZapadEVMkompleks" PO [industrial association] is now completing translation of the SPOK for the OS YeS, using the materials and programs for the SPOK developed at the Institute of Cybernetics of the UkSSR Academy of Sciences and sent to the NII [scientific research institutes] and UTs [expansion unknown].

[47-8545]

8545
CSO: 1863

UDC 681.3.00

AUTOMATION OF THE FILING AND PREPARATION OF ASU SOFTWARE DOCUMENTATION

Moscow AVTOMATIZATSIYA PROTSESSA VEDENIYA I IZGOTOVLENIYA DOKUMENTATSII PROGRAMMNOGO OBESPECHENIYA V ASU in Russian 1980 signed to press 20 Mar 80 pp 2-8, 131-132

[Annotation, foreword and conclusion from book by B. M. Mikhaylov, Sovetskoye radio, 144 pages]

[Text] Annotation

In the book the principles of the systems approach, permitting automation of the the filing and preparation of documentation, are formulated. The structures of the data bank included in the hierarchic storage system are described. The principles of organization of interactive working conditions of the system and computer-aided editing of textual documentation are examined. Special attention is given to problems in the synthesis of algorithmic flowcharts. Procedures in solving tasks in the layout, arrangement and drawing of connecting lines that arise in formulating the structure of a document are discussed in detail.

The book is intended for developers of automated design system software. It can be useful to scientific workers, graduate students and undergraduates specializing in that area.

Foreword

In our country a course has been taken toward increase of the effectiveness and quality of work in all sections of productive activity. ASU designers face the task of reducing the required times and improving the quality of planning, which usually represents a very labor-intensive process. The final result of that process is the preparation of documentation. This applies primarily to software documentation, as its volume amounts to about half the total volume of all ASU documentation.

Traditional manual methods of preparing documentation substantially increase the time required for ASU development and introduction, as those methods are very labor-intensive and the obtained documentation contains many errors. All this prevents efficiency and high quality of the developments. The process of introducing changes in sets of documentation also is very labor-intensive and in a number of cases has the result that the prepared documentation is reprocessed in the stage of adjustment of the system. During system operation and modernization work also is done on the introduction of changes in documentation already issued.

Until recently the manual method of obtaining documentation was the only one possible. True, work has been done on mechanizing the issuance of documents, but it has been reduced to facilitating certain operations (for example, drawing symbols on templates, attempts to solve particular tasks by means of complex mechanical devices, etc). That work did not involve the methods themselves, but only facilitated somewhat the processes of document preparation. Attempts to obtain documentation by machine methods relate mainly to the compilation of specifications, the classification of inventories of materials and articles, etc. That documentation had to be included in documentation sets done manually. In general the work on machine methods of filing documentation has not been successful because of the impossibility of completing the documentation in accordance with existing GOST (All-Union State Standards) requirements, difficulties connected with the fact that the proposed systems of documentation filing have made no provision for the automation of those processes, and the low quality of the documentation obtained on computer displays.

One way out of such a situation is automation of the process of planning, filing and preparation of documentation. The introduction of new GOST's gives a powerful impetus to the development of work on the machine preparation of documentation.

The development of documentation by means of computers is generating new principles of their creation and determines the new completeness and new rules for their implementation. In all countries great importance is attributed to questions in the standardization of documentation and the development of rules for the formulation, recording and copying of documents, done by machine methods. In the USSR the Committee for Standards, jointly with the CEMA member-countries, has begun the development of a number of state standards and all-union state standards which will permit improving the system of processing, recording and circulating documents, including software documents.

The adoption of new state standards and all-union state standards will permit:
--improving the quality of the development of documentation;
--organizing machine storage and computer-aided proofreading;
--eliminating the issuance of additional documents which duplicate one another;
--facilitating document exchange between various developers and organizations, etc.

Analysis of Soviet and foreign experience shows that the solution of individual problems arising in the process of document filing and preparation does not lead to the desired result. Systems which solve such tasks as a whole must be developed. Work on the machine preparation of documentation is being done intensively both in our country and abroad. Very great successes have been achieved by IBM, Lockheed and ICL, which prepare over 80 percent of all documentation by means of computers. "Flow chart" program complexes for obtaining drawings of algorithmic schemes and "Format" for editing textual documentation are known.

Similar work is beind gone in our country in the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences (Kiev), the All-Union Scientific Research and Planning Institute of Automated Control Systems for Sectors of Industry (Moscow), in the Scientific Research Center of Electronic Computer Equipment (Moscow) and in a number of other organizations.

In the presented work an attempt is made to generalize experience in work on the machine preparation of documentation, done by the author with a group of associates in the period from 1970 to the present time.

In the first chapter the basic principles of the organization of an automated system for the filing and preparation of software documentation are examined. The structure of such dystems is determined above all by the composition of the software which accomplishes given functions. It should be noted that the system is an open one, that is, there is a possibility of enlarging it during the period of operation. A formal description of the system is given on the basis of concepts of the set theory and its representation in the form of a two-level hierarchic structure. The structure of the system software is presented.

In the second chapter the basic principles of the organization of integrated data storage in the system are discussed. When there are large volumes of stored documentation the file organization of data cannot assure the necessary access time and the complete set of data needed by the user of the system for his request. It is advisable to use a data bank to eliminate those shortcomings. A data bank is defined as a complex which includes in itself an information system that has a special structure, software and hardware which maintain that system. Together with that the application of data bank with a common structure does not satisfy the required time of access for requests and worsens the efficiency of the storage. This leads to a need to add to the data bank an abstract structure (in the form of a dynamic data model) with the introduction of an adaptive coupling.

In the third chapter the organization of interactive conditions in the system is described. Usually one-time, problem and system users function in interactive conditions; they differ from one another above all in their qualifications, knowledge of the system's possibilities, etc. Two main types of requests are used in the system: rigid and free. Arising in connection with that is the problem of interaction of the user with the system, which can be conducted in a natural language. However, that gives rise to serious difficulties in the construction of a formal linguistic model. Therefore in the system a language of interaction is used, one similar to a natural language and constituting a regular subset of it. To increase the working effectiveness of the users a two-level priority system of servicing is used. A strategy of relative priority is used as the servicing discipline. Such a priority system permits minimizing the mean waiting time of the requirement for servicing the user.

In the fourth chapter the principles of solution of the task of automatic formation of the structure of documents presented in alphanumeric and tabular form are shown. In processing such documentation it is absolutely necessary to take into consideration the GOST's (such requirements for them, for example, as the obtaining of documents of a definite format, the allowable number of symbols per line and per page, the introduction of allowed conventional abbreviations, etc). One fairly complex problem is the task of logical division of words into syllables to form a transformation. Very effective is a method based on analysis of the combinations of vowels and consonants in a word containing elements of orthographic analysis. The task of minimizing storage volume arises in the storage of textual information. Line-by-line coding, which is the main method of presenting textual information, is not optimal from the point of view of the probable position of characters. Reduction of the number of characters not carrying an information load and reduction of

the mean redundancy of the letters of the alphabet permits reducing by almost half the memory volume necessary for the storage of aphabetic textual information.

In the fifth chapter problems are examined which arise during arithmetic synthesis of a graph of algorithm schemes. The main requirement presented for graphic documentation and, in particular, for algorithm schemes, is clarity. This concept cannot be defined formally. Therefore heuristic criteria are introduced. Graphs of algorithm schemes are synthesized in several stages. Among the principal stages is arrangement, that is, the breakdown of algorithm schemes by pages, the disposition of graphic symbols on the page and the drawing of connecting lines between symbols. Such tasks are solved separately for several reasons. Firstly, the tasks of arrangement, disposition and the drawing of connecting lines have such a complicated connection that it is practically impossible to express it formally in a single formulation of the problem and all the more so with a single general functional. Secondly, the reason for the conditional separation of the problem is the fact that synthesis of the graph as a whole leads to large machine time expenditures. This can be reduced to no advantage of machine preparation of algorithm schemes.

In the sixth chapter the task of arrangement of algorithm schemes by pages is solved. The task is solved in two stages. In the first stage the number of pages required for arrangement of the algorithm scheme is determined. In the second, the subset of graphic symbols on a page is formed with consideration of their connection.

In the seventh chapter the task of disposition of graphic symbols on the page is solved. A minimum length of the distances between symbols is taken as the criterion of optimality. This is caused by the need to dispose the graphic symbols so as to substantially simplify the drawing of connecting lines. The symbols are arranged in groups in which they are most connected with one another. To determine such groups, which are called paths, the concept of indicator of connection of the path peaks is introduced. The obtained variants of arrangement are evaluated from the total length of the distances between the arranged symbols.

In the eighth chapter the task of drawing connecting lines between the arranged graphic symbols is solved. The drawing of connecting lines is the most complex stage in the synthesis of the graph of algorithm schemes, for the quality of the obtained drawing. In the solution of the task of drawing connecting lines, in the first stage it is required to determine the sequence of their construction, and in the second--to directly construct connecting lines between symbols. The connecting lines are constructed by means of simple heuristic algorithms, and if that is not successful, then by means of a modified radial algorithm.

In conclusion, recommendations are given on the use of the proposed methods to solve analogous problems and ways to modernize and improve them.

The author wishes to express his deep gratitude to honored worker of science and technology of the RSFSR, doctor of technical sciences, Professor Ye. V. Armenskiy, Corresponding Member of the USSR Academy of Sciences N. Ya. Matyukhin, doctor of technical sciences, Professor K. A. Pupkov and Professor P. P. Sypchuk for constant support and valuable comments expressed and thanks Candidate of Technical Sciences L. V. Zaytseva, Candidate of Technical Sciences V. A. Pustyrev and graduate students O. D. Gonikhin, A. R. Kadiyev and A. S. Mironov for great help in the preparation

and writing of the manuscript, and also to T. A. Bazhanova for putting it in final form. The author thanks reviewers L. A. Ivanov, V. G. Volkhover and N. G. Gaganov for specific comments which permitted improving the content of the manuscript.

Brief conclusion

Questions regarding the machine preparation of documentation are very urgent at the present time. In the present book an attempt has been made to generalize available experience on problems in automating the development of program documentation. The development of systems like the automated system for documentation filing and preparation [avtomatizirovannaya sistema vedeniya i izgotovleniya dokumentatsii--ASVID] represents a laborious process and requires large expenditures of time of experienced programmers. Experience shows that the described procedure can also be applied for other types of documenttion, for example, functional and circuit diagrams in basic elements, microprogrammed logical circuits, organizational and administrative documentation, etc.

It is obvious that machine methods of preparing documentation are promising and require further solution and development. One of the main problems consists in the development of standards for systems of automated planning, including systems for machine preparation of documentation. Standards must reflect the basic principles of planning and the arthitecture of systems being developed, the input and output information requirements, requirements for the composition of the software and hardware, etc. The absence of standards leads to the appearance of systems of planning automation "incompatible" with one another under operating conditions.

It is necessary to organize an all-union (not a branch) fund of algorithms and programs, with moral and material incentive of organizations which have contributed packages of applied programs to that fund. The absence of such a fund has the result that a considerable number of organizations are engaged in parallel development of the same systems. This involves a diffusion of the scientific potential and an unnecessary duplication of scientific development work.

With the appearance of computers of the SM series (models SM-3 and SM-4), with large immediate-access and external stores and a fairly high speed, the development of systems of machine filing and preparation of documentation on computers becomes promising.

New GOST's must be introduced which would permit legitimizing documentation made by machine methods and remove the problems arising during transfer to normal inspection of documentation for systems being developed. It is necessary to solve the question with expansion of official storage of documentation for machine information carriers (such as magnetic tapes and disks), since at the present time there is duplication of machine carriers of information and of documentation done manually. The problem of improving the quality of reproduction of documentation on standard computer peripherals and expansion of the set of them and of the used symbols also requires its own solution.

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CSO: 1863

APPLICATIONS

UDC 658.56.012.7

AUTOMATED PROCESSING OF SPECTRUM ANALYSIS RESULTS

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, 1980 pp 19-20

[Article by V. M. Porokhnya, engineer]

[Excerpts] In the foundry shop of the Pavlodar Tractor Plant imeni V. I. Lenin (PTZ) spectrum analysis units are used for chemical analyses of steels and cast irons. One of the most improved installations of that type is the DFS-41 vacuum photoelectric unit, intended for quantitative analysis of steels and cast irons for sulfur, phosphorus, carbon, manganese and other elements. A shortcoming of the unit is that its measuring instrument issues the values of quantitative analysis in millivolts, that is, measures the intensity of radiation of the spectral line of test samples. It is presented to the steel worker as the content of the element in percentages. Transmission of amounts of intensity expressed as percentages requires special calibration graphs, constructed on the value of standard samples by the laboratory assistant-operator. The participation of man in the direct measurement and calculation of values introduces a subjective factor into the process and increases the error of solution of the problem and the time required for issuance of the final result to the steel worker.

In the tractor and farm machine building sector a number of plants are equipped with DFS-41 spectrum analysis units. At the same time, computer and data processing centers are functioning at the plants.

Taking these circumstances and the stated shortcomings of the DFS-41 diffraction spectromenter into consideration, and also the high cost of new, more improved instruments, the Pavlodar Planning and Design Institute of Automated Control Systems has simulated the main technological solutions and has developed algorithms for the transmission of instrument indications expressed as a percentage to an M-6000 computer, with testing of the model under the working conditions of a steel foundry shop at the PTZ.

After adjustment of programs and test-industrial operation of the system for computer-aided processing of spectrum analysis results it was established that the time required for obtaining a response to the question when magnetic disks are used is 6 s; the time required for an approximate analysis has been shortened by 5 min; casting scrap has been reduced by 85 percent in chemical composition; furnace loss of metal has been reduced by 0.35 percent and electric power consumption by 3.5 percent. The use of a mathematical model of the process made it possible to reduce

the error in determination of the percentage concentration of chemical elements in the steel for carbon, silicon and manganese by 0.01 percent. The obtaining of high technical and technological smelting indicators made it possible to obtain an annual saving of 47,000 rubles from introducing the system in the steel foundry shop.

[55-2174]

2174
CSO: 1863

OFFICIAL CLASSIFIER OF TRACTOR PARTS PUBLISHED

Leningrad OBSHCHESOYUZNYY KLASSIFIKATOR. PROMYSHLENNAYA I SEL'SKOKHOZYAYSTVENNAYA PRODUKTSIYA in Russian 1980 pp 3-5, 163

[Official information, annotation, text, and table of contents of booklet "Obshchesoyuznyy Klassifikator. Promyshlennaya i Sel'skokhozyaystvennaya Produktsiya" (All-Union Classifier. Industrial and Agricultural Output) Class 47 — "Tractors and Agricultural Machines," 1 75 056, Vol 9, Subclass 47 6(47 6314 1491 - 47 6512 0329), "Aggregates, Assemblies and Parts of Tractors"]

[Excerpts] This classifier was developed by the Central Scientific Research and Design Institute of Combustion Equipment for Automobile, Tractor, and Stationary Engines (TsNITA: Director of TsNITA — Yu. B. Svirodov; project manager — S. A. Chelov; performer of work — Ye. N. Kollerov), the Main Computing Center of USSR Gosplan (deputy chief — V. B. Bezrukov; project managers B. T. Khaninev and V. I. Dobryakov), and the All-Union Scientific Research Institute of Technical Information, Classification, and Coding of the USSR State Committee on Standards, Measures, and Measuring Instruments (VNIIKI: deputy director — A. A. Sakov; project managers — G. V. Koloneytseva and S. N. Konovalova; performer of work — V. V. Gvozdeva).

This classifier was introduced by the Ministry of Tractor and Agricultural Machine Building (Deputy Minister — N. N. Parasov).

This classifier was prepared for ratification by VNIIKI (deputy director — A. A. Sakov).

This classifier was ratified and put into effect as of 1 January 1976 by Decree No 56 of the USSR State Committee on Standards, Measures, and Measuring Instruments of the USSR Council of Ministers, dated 29 December 1975.

Annotation

The present volume of the sectorial part of the All-Union Classifier of Industrial and Agricultural Output (OKP) contains systematized lists of "original"(not borrowed) aggregates, assemblies, and parts of tractors in traction classes between 1.4 and 5 tons with assigned 10-digit OKP codes for the subclass 47 6000 in the range from 47 6314 1491 to 47 6512 0329.

The necessary explanations to the system of classifying and coding articles is given in the introduction to the first volume of each subclass.

47 6300 Aggregates, Assemblies and Parts of Tractors in Traction Classes Between 1.4 and 2 Tons

Code 1	KCh* 2	Product Name 3	Number of Drawing 4
47 6314		aggregates, assemblies, and parts of T-50V, T-54A, T-54V, T-54D, T-54L, T-54S, and T-70S tractors	based on drawings of Kishinev Tractor Plant (city of Kishinev)
47 6314 1491		right siderail (longeron)	based on drawing of Kishinev Tractor Plant (city of Kishinev)/ 54S-32 01 070-G
47 6314 1492		" "	70S-32 01 070
47 6314 1493		siderail (longeron)	54-32 01 071-B
47 6314 1494		— welded	54-32 01 071zam

* [Expansion unknown, possibly "classification number"; column is blank in original text]

Table of Contents

[53-11176]

11176
CSO: 1863

UDC 621.391:61

SOME PRINCIPLES OF THE CONSTRUCTION OF A COMPLEX FOR AUTOMATED CARDIOLOGICAL INFORMATION PROCESSING WITH THE M-6000 COMPUTER

Kiev KIBERNETIKA I VYCHISLITEL'NAYA TEKHNIKA in Russian No 45, 1979 pp 91-94

[Article by T. A. Volkhonskaya, E. M. Maslova, A. K. Galitskiy and M. A. Chekaylo, Institute of Cybernetics, Ukrainian SSR Academy of Sciences, Kiev]

[Text] Increase of the labor productivity of medical personnel in preventive-medical institutions, ambulatory polyclinics, sanatoriums and resorts involves the algorithmization and automation of medical servicing in those institutions. An inseparable part of that work is the collection and processing of primary medical information, the setting up of diagnosis and evaluation of the state of the patient, prediction of changes of the state of the patient and the production of corresponding effects [1].

Automation of the process of collection and processing of primary medical information is being done in two directions at the present time. Firstly, there is the creation of standardized formalized histories of disease, forms, questionnaires, into which information is fed by the physician or the patient himself and secondly, the processing of analog information characterizing the state of the physiological systems of the organism. The use of small machines seems very advisable for that purpose. This is connected above all with the need to process data in real time, the processing of large volumes of analog information (over 400 kbytes), the processing of fairly slowly varying processes (for example, with a frequency of 0.5-10 Hz) and the considerable length of investigations.

It is natural that the solution of such tasks with large electronic computers often does not seem possible because of the existence of separate territories, the distance of objects of investigation and control from the computer center and the high cost of computers.

In the creation of such complexes it is necessary to determine in advance the range of problems to be solved by the system. Thus, for evaluation of the state of the cardiovascular system the system must provide the following: input of the patient's recorded data and other parameters from a printer or teletype; the registration of research; the coding, filtration and recognition of the required elements of curves; calculation of the indicators characterizing the electrical and mechanical activity of the myocardium, and also the principal hemodynamic indicators; automated monitoring of data input and output, with correction of errors; the accomplishment of scientific work to determine the optimum research conditions; organization of the

arrays in accordance with different research procedures on machine information carriers; preliminary analysis of the obtained indicators.

If we have determined the range of tasks to be solved by the system and also have analyzed the stages in the processing of analog and digital information and its volume, the necessary throughput of the system, the structure and software of the complex and its possible economic effectiveness, we can proceed to select the system's hardware.

Selection of the electronic computer seems to be the most complex and important task. Its technical characteristics and functional possibilities will contribute to a considerable degree to the successful solution of the set task. Computer selection assumes the substantiation of its following characteristics: a) the effective speed of the arithmetic equipment; b) the capacity of the external storages; c) the capacity of the main storage; d) the speed of the input and output devices.

At the present time the creation of such systems on the basis of computers of the ASVT series (the modular system of computer technology) (the models M-6000, M-400, SM-3, etc) seems very promising. Those computers have developed peripherals, which is a very important factor in the creation of systems intended for the processing of primary medical information. The presence of translators from FORTRAN and ALGOL permits using programs written in those languages for other computers, and this considerably facilitates and accelerates the work. True, translatable programs occupy a considerably greater storage volume than programs written in computer codes. In the first stage, however, they can completely satisfy the researcher.

Starting from analysis of the above-presented requirements, the apparatus complex of the system created by us consists of an M-6000, a device for communication with the object (USO), an ELKAR-6 electrocardiograph, an RPG2-01 rheograph, a visual monitor of input information and a teletype. The USO connects an analog-digital converter and commutator. Later the ELKAR-6 electrocardiograph will be replaced by a multichannel biopotential amplifier. This will permit considerably improving the amplitude-frequency characteristics and noise immunity of the signals being processed (figure).

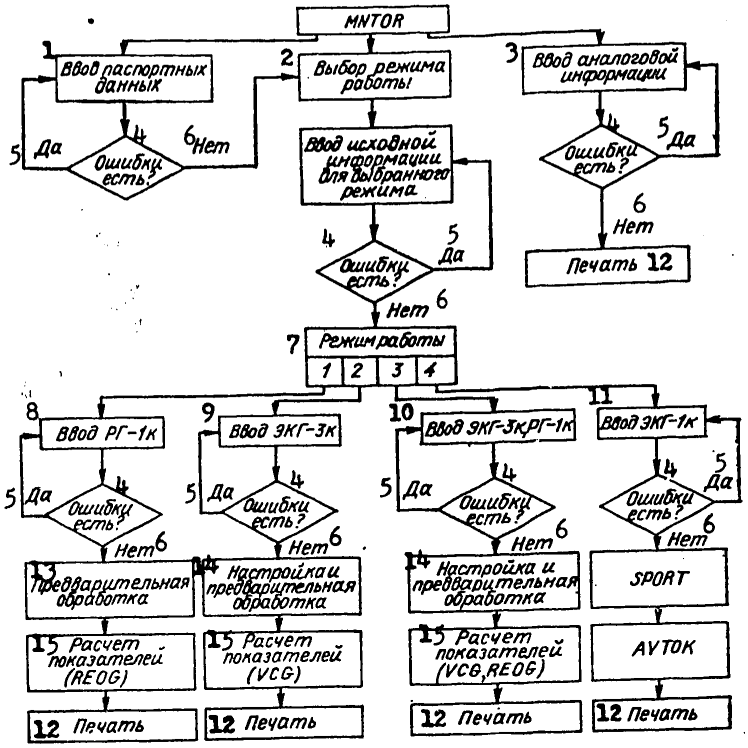
The teletype is used for input of recorded and starting data of the patient for calculation of the indicators by means of a given procedure. Then the analog information is input and processed and the data are printed.

In the preparation of software and writing of programs the principles of hierarchic structure and multiple use of subroutines was used. The software of the complex can be divided into the following three parts.

1. Subroutines (ACP, SDWIG, NASTR, ROZIK, VINT, FILTR and IZO) assuring adjustment of the system and preliminary processing of arriving cardiosignals.

2. Subroutines (MAXD, VCG1, VCG2, RECG1, RECG2, etc) for calculation of various indicators, depending on the procedures used.

3. Subroutines (AVTOK, GRAF, SPECTR, MCORR, etc) which accomplish statistical processing of data. Selection of the regime (with consideration of the goal of the investigation) makes it possible to obtain qualitatively different algorithms for analysis of starting data arriving on the system input.



Block diagram of work of a complex based on the M-6000 computer for automated processing of cardiological information.

1 -- Recorded data input
2 -- Selection of working conditions
3 -- Analog information input
4 -- Is there an error?
5 -- Yes
6 -- No
7 -- Working conditions
8 -- Input RG-1k
9 -- Input ECG-3k
10 -- Input ECG-3k, RG-1k
11 -- Input ECG-1k
12 -- Printer
13 -- Preliminary processing
14 -- Adjustment and preliminary processing
15 -- Calculation of indicators

We will present a brief description of the work of some subroutines. ASP accomplishes the input of analog information into the computer over one or several channels simultaneously. The quantizing step is given by a timer. Since the interrogation of channels is done by a commutator, a shift forms between the processes being registered. SDWIG accomplishes shift of introduced readings. Used for those purposes is piecewise-linear approximation of a linear type, all the readings are translated with a coupling to readings recorded on the first channel. NASTR adjusts the system assuring the obtaining of parameters needed for recognition of the structural elements of cardiosignals (for ECG the QRS complex and the P and T waves).

Preliminarily during continuous ECG registration the R wave is recognized and the interval RR is measured. Starting from the given interval $\overline{RR}$ the proper values of the cardiac activity of interest to us are calculatted in accordance with the formulas proposed by V. L. Karpman [2], and that permits determination of the number of readings corresponding to the proper values of the length of the QRS complex of P and t waves at the given quantization step. VINT localizes the section corresponding to the QRS complex with respect to the totality of three orthogonal leads: $F(i) = \sum_{i=1}^{3} X_i(i)$, where F_i is the ordinate of the formed auxiliary curve at the point $i = \overline{1,2,\ldots, N}$.

With sliding of one step in sections corresponding to the proper length of the QRS complex, the partial sums

$$A_j = \sum_{i=j+1}^{j+l_{QRS}} |F_{i+1} - F_i|, \qquad j = \overline{0, 1, \ldots, N - l_{QRS}},$$

are calculated and max A_j is found, where j gives a maximum to the partial sum and is the assumed start of the QRS complex. Taking into consideration that the P wave is the QRS complex within the interval (0.4 of the length $\overline{RR}$ - l_{QRS}) and the T wave after that, within the interval (0.6 of the length $\overline{RR}$ - l_{QRS}), we select the initial array fragment we need. Having selected in the initial array only the fragments we need and having changed the range of representation of numbers, we improve the exactness of calculations while preserving the same occupied storage.

FILTR establishes the threshold noise level for each of the fragments and carries out digital filtration by the quadratic curve method. The number of points n_1 on which parabolas are constructed and the sliding step n_2 ($n_2 < n_1$) depends on the frequency of the analog-digital converter and the natural frequency of the signal. IZO includes a fragment of realization ($XN_i = \{X_{j-NP}\}$), where i is the ordinal number of the lead; $j = \overline{NP + 1, NP + 2, \ldots, kT}$. This subroutine accomplishes recognition of the initial and final points of the QRS complex and the P and T waves. A distinctive feature of the algorithm is that in it use is made of the principles of dynamic programming and differently directed analysis of the curve from individually established base points.

RECG accomplishes recognition of one rheogram period and the calculation of 12 indicators of the hemodynamics, including the stroke and minute volumes, the peripheral resistance, etc. The VCG subroutine accomplished calculation of indicators characterizing the electrogenetic function of the heart, including the area of the lateral surface of the QRS loop, T, the amount and spatial position of all the moment vectors, the number of which depends on the quantization step and the value and spatial position of $\overline{QRS}_{max}$, $\overline{T}_{max}$, $\overline{Int}_{QRS}$, $\overline{Grad}$ and the angle between (QRS_{max}, T_{max}). Those parameters will be used later in the model of the electrical activity of the myocardium developed by us. SPORT serves for determination of the R-R intervals during long registration of an ECG.

There is a number of programs of mathematical statistics for processing the experimental results.

Those subroutines are controlled by means of the subroutine MNTOR, which permits setting the required working conditions, introducing and correcting the starting information and deriving the necessary information.

By means of that subroutine reported data of the patient are introduced, including physiological and test data, an identifier, the disease history number, the investigation number, age, sex and other data. Then the required working conditions are set from the teletype keyboard, after which MNTOR issues the subroutines necessary for accomplishment of the set working conditions. After selecting the working conditions we introduce the starting information required for them. Thus, in processa rheogram by the Kubichek method it is necessary to introduce data on the distance and resistance between the electrodes and also, for calculation of the hemodynamic indicators, data on the arterial pressure, the aortal section, the body surface, etc. If analog information must be introduced for various scientific purposes, provision is made in MNTOR for its introduction without involving a given procedure.

At the present time we can accomplish the following working conditions: 1) input only of a rheogram and calculation of the hemodynamic indicators; 2) input of three orthogonal ECG leads; 3) input of the rheogram and three orthogonal ECG leads; 4) input of several rheogram periods and calculation of the autocorrelation function.

When the first working conditions have been selected the rheogram is introduced and processed and the hemodynamic indicators also are calculated. Subroutines ACP, FILTR, MAXD and REOG work in that case. When the second working conditions have been selected an orthogonal ECG is introduced over three channels. Indicators characterizing the electrical function of the myocardium are issued to the printer. When the third working conditions have been selected the electrocardiograms and rheogram are processed together and indicators characterizing the electrical and mechanical activity of the myocardium are issued to the printer. When the fourth working conditions have been selected several rheogram periods are recorded and the autocorrelation function is calculated later.

At the present time the volume of the used programs amounts to over 16 kbytes. All programs were written in the FORTRAN language or the M-6000 mnemonic code.

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LIST OF PAPERS PRESENTED AT INFORMATION THEORY SYMPOSIUM

Moscow-Tbilisi PYATYY MEZHDUNARODNYY SIMPOZIUM PO TEORII INFORMATSII. TEZISY DOKLADOV (Fifth International Symposium on Information Theory. Abstracts of Papers) in Russian 1979 Part I signed to press 12 May 79 pp 3-12 Part II signed to press 10 May 79 pp 3-12

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Part I

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TWENTY-FIVE YEARS OF OPERATION OF USSR ACADEMY OF SCIENCES COMPUTER CENTER

Moscow ZHURNAL VYCHISLITEL'NOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 20, No 5, Sep-Oct 1980 pp 1091-1092

[Text] When digital computers first appeared in 1955, the country's first specialized scientific institute--the Computer Center of the USSR Academy of Sciences--was created. The name of this institute indicated both the theme of its work as well as the research tool. The organization immediately became the destination of a pilgrimage which brought requirements to calculate the strength of a turbine blade, to determine the operating mode of an electron microscope, to process the results of geodesic measurements ... However, the young VTs [Computer Center] organization did not wish to become a computing shop filling random orders. From the very beginning, the VTs departments undertook active scientific research, the outlook of which was based on important requirements for the development of science and technology. At the same time, the customers' interests were supported by carrying out joint projects. In accomplishing these, the customers mastered computational mathematics and computer use, and the circle of specialists in these areas was thus expanded.

In the twenty-five years of existence of the VTs USSR Academy of Sciences, the basic scientific trends have been grouped around the three major themes of computer software, problems involving either equations with partial derivatives or kinetic equations, and research in cybernetics.

Theoretical work on current problems in computer software is being conducted chiefly in the area of programming languages, interactive systems and data bases. The achievements in this area are receiving practical implementation on domestic computers, particularly those operated by the VTs USSR Academy of Sciences; this implementation includes the creation of translators, multiple-user systems and information retrieval systems.

The development of numerical methods for equations in partial derivatives and for kinetic equations is proceeding successfully. A great deal of work has been done on the gas dynamics of stationary and non-stationary flows, on the dynamics of radiating and rarefied gas, on the investigation of viscous fields, and on filtering and strength theory. Along with this, tables of special functions have been computed and published, and nomographic methods and applications are being developed.

Cybernetic research is expanding. Economic problems are being modeled, the theory of large systems is being developed, as are pattern recognition methods and mathematical ecology. Optimization theory is developing. The applications include numerous problems of the national economy, particularly automating the planning of equipping for the exploitation of oil deposits, solving problems of the utilization of water resources and investigating game-type problems.

The VTs USSR Academy of Sciences has come from the first "Ural" and "Strela" computers to a BESM-6 time-sharing machine. Projects in the area of technical cybernetics are improving the VTs capabilities for computer utilization. Preparation for the installation and mastery of more sophisticated computers is underway.

The VTs organization is rapidly picking up the development of new trends associated with computer applications. The institute includes new laboratories which are responsible for such research. The execution of scientific themes results in packets of applications programs which become public property.

When the VTs was organized in 1955, its staff, headed by Academician A. A. Dorodnitsyn, consisted of one doctor of science and 6 candidates of science. These have not been joined by an academician, 3 corresponding members of the USSR Academy of Sciences, 20 doctors and 150 candidates of science. A number of major VTs projects have received the Lenin, the State as well as several named prizes.

A large number of students, aspirants, trainees and assigned personnel are always working within the VTs. The Institute has trained a huge number of highly qualified scientific workers from other organizations, particularly from institutes of the union republics and socialist countries. Ties with outside organizations are continually being strengthened, and provide inestimable benefit to both sides.

The editors of the Journal congratulate the staff of the VTs USSR Academy of Sciences upon their twenty-fifth anniversary, and wish that they may retain its most important inherent feature--the ability to remain young in the selection of theme and in the dynamics of development of scientific research.

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BORIS NIKOLAYEVICH PETROV--OBITUARY

Moscow IZVESTIYA AKADEMII NAUK SSSR. TEKHNICHESKAYA KIBERNETIKA in Russian No 5, 1980 pp 3-4

[Obituary]

[Text] Soviet science has suffered a severe loss. An outstanding Soviet scientist and organizer of science, vice-president of the USSR Academy of Sciences, chairman of the Council "Intercosmos" under the USSR Academy of Sciences and the Scientific Council for the Complex Problem "Cybernetics" under the presidium of the USSR Academy of Sciences, academic secretary of the Department of Mechanics and Control Processes of the USSR Academy of Sciences, deputy of the RSFSR Supreme Soviet, Hero of Socialist Labor, Lenin Prize and USSR State Prize laureate, Academician Boris Nikolayevich Petrov died on 23 August 1980.

A very eminent scientist in the area of control problems has departed this life, a talented organizer of space science and international collaboration in that area, an eminent social worker, a remarkable man who gave all his life to the service of his motherland, to the great cause of the building of communism.

B. N. Petrov began his scientific activity in 1939 in the Institute of Control Problems (Automation and Telemechanics) after graduation from the Moscow Power Institute. Intrinsic to all his scientific activity was a characteristic feature--an applied directivity, an orientation toward the solution of practical problems. Important scientific results were already obtained in the first works of B. N. Petrov, results which permitted creating a series of multi-position automatic machines which were widely used during the Great Patriotic War in the production of military equipment. Subsequent work of B. N. Petrov was connected with the development of the scientific principles of the construction of automatic copying systems, the creation of approximate methods of integrating nonlinear differential equations with the development of the mathematical apparatus for structural transformations of models of dynamic systems.

Scientific investigations in algebraic automated control system theory have advanced him into the ranks of eminent and authoritative scientists of our country. Extending that direction, B. N. Petrov recently started working on inverse problems of automated control theory which he has not succeeded in completing.

B. N. Petrov was one of the founders of the theory of invariance of automated control systems. He formulated the two-channel principle and established the

criterion of realizability of invariance conditions in linear and nonlinear systems. The principles of the theory of nonlinear servomechanisms were created under his leadership and with his direct participation. Of great practical importance are the applied research and developments of B. N. Porter in the area of the control of power and propulsion installations of mobile objects.

B. N. Petrov headed the work on information problems of control theory during entropy description of controlled technological processes under conditions of indeterminacy. The results of that work are opening up new possibilities in the theory and practice of automated control systems.

B. N. Petrov made an outstanding contribution to the creation of automated systems for the control of industrial objects and objects of new technology on the basis of the application of computer hardware and to the development of automation of scientific research and planning. In his work basic results were obtained in the theory of terminal, self-adjusting and adaptive automatic systems and systems with a variable structure, which with his participation have found wide application in the creation of systems for the control of technical objects and objects of aeronautical engineering and space-rocket technology.

For outstanding scientific achievements B. N. Petrov was elected a corresponding member of the USSR Academy of Sciences in 1953 and a full member in 1960.

In recent years B. N. Petrov led scientific cosmic space research programs. Heading the "Intercosmos" Council under the USSR Academy of Sciences, of which he was chairman in 1966, B. N. Petrov made an enormous contribution to the development of international collaboration in the area of the investigation and use of cosmic space.

B. N. Petrov was a founder and editor-in-chief of the Journals IZVESTIYA AN SSSR. TEKHNICHESKAYA KIBERNETIKA (Izvestiya of the USSR Academy of Sciences. Technical Cybernetics) and PROBLEMY UPRAVLENIYA I TEORII INFORMATSII (Problems of Control and Information Theory).

B. N. Petrov was a member of the Committee for Lenin and State Prizes in the Area of Science and Technology under the USSR Council of Ministers. He devoted much attention to the preparation and training of scientific personnel. Since 1944 he had taught in the Moscow Aviation Institute imeni S. Ordzhonikidze, and since 1950 had headed the Department of Automatic Aricraft Control Systems in that institute.

Testifying to the broad international recognition of the fruitful activity of B. N. Petrov is his election as a foreign member of the academies of sciences of a number of socialist countries and a full member of the International Academy of Aeronautics, and also his being awarded foreign orders and medals.

The Communist Party and the Soviet government have highly valued the services of B. N. Petrov to the motherland. He was awarded the title of Hero of Socialist Labor, five orders of Lenin and the orders of the October Revolution, the Red Banner of Labor, the Red Star and medals.

The bright memory of Boris Nikolayevich Petrov, an outstanding scientist, a talented organizer of science, an ardent patriot and a man of great spiritual purity and charm, will always be preserved in the hearts of the Soviet people.

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INFORMATION EXCHANGE IN COMPUTER NETWORKS

Moscow INFORMATSIONNYY OBMEN V VYCHISLITEL'NYKH SETYAKH in Russian 1980 signed to press 15 January 1980 pp 2-17, 35-65

[Annotation, foreword and excerpts from book edited by Doctor of Technical Sciences S. I. Samoylenko, Izdatel'stvo "Nauka", 2400 copies]

[Excerpts] A study is made of the principles of the construction and analysis of computer networks, data transmission methods, and control problems in computer networks. A special role is assigned to optimizing the design of the computer networks, simulation, noiseless coding and insurance of data reliability and also data compression during data gathering, transmission and storage.

The collection is designed for a broad class of specialists in computer engineering and data transmission systems.

FOREWORD

This collection includes papers on the problematics of information processes in computer networks discussed at the meetings of the Second All-Union School on Computer Networks organized by the Scientific Council of the USSR Academy of Sciences on the complex problem of cybernetics.

Recent years are characterized by intense development of computer networks making use of the method of packet switching. They have the following useful properties:

The possibility of efficient use of the carrying capacity of the communication channels when transmitting relatively short messages;

Insurance of relatively short delay time without tying up the carrying capacity of the communication channels with the interacting subscribers;

High reliability of transmission as a result of using powerful error-protection means executed by the connected computers in the network;

Reliability connected with the possibility of using bypass routes on failure of individual sections or junctions of the network (networks with packet switching can be reorganized quickly when there is a change in information flows and on occurrence of damage or overload in indivudual junctions; therefore they have high reliability and viability);

Improvement of the secrecy of transmission as a result of the fact that individual parts of the messages can be transmitted over different paths and the complete messages do not pass through intermediate junctions.

Under defined conditions the networks with packet switching can be the basis for constructing the data transmission network. In addition, the studies of the efficiency of networks with packet switching have demonstrated that in some cases they are inferior to networks with channel switching.

The basic conclusions obtained from a comparative analysis are in general as follows: in the case of short messages it is efficient to use packet switching; in the case of long continuous messages, channel switching. It follows from this that the efficiency of utilizing the carrying capacity of

communication channels and, consequently, the transmission cost with different types of switching essentially depend on the nature of the transmitted messages.

However, the exact values of the message parameters on which the efficiency of the switching method depends are unknown not only when designing the network, but also in the process of operation and maintenance of it; therefore the unique selection of the optimal switching method for the designed network is in practice an unresolvable problem. The only possibility of insuring high network efficiency is use of adaptive procedures in which different switching methods can be used, and the distribution of the carrying capacities between them can vary as a function of the traffic variations.

Recently general principles and algorithms of adaptive switching have been developed which combine the methods of packet and channel switching. The method of adaptive switching provides for increased use of the carrying capacity of the channels in cases where sufficiently complete data on the expected characteristics of the transmitted messages are unavailable in designing the network and also when the traffic varies with time.

The increase in efficiency of using the channels in the presence of adaptive switching is achieved by using two mechanisms: 1) redistribution of the network channel carrying capacity among the messages transmitted in the packet switching mode (PS) and the channel switching mode (CS); 2) use of the pauses in the component messages to transmit packets.

The studies in the field of analysis and development of computer networks have been conducted in recent years along many paths, from which it is possible to mention the basic ones: the investigation and comparative analysis of various switching methods; development of network control procedures with different switching methods; development of methods of solving optimization problems connected with network design and network control; development and analysis of the protocols of interaction among subscribers and the network, individual components of the network, between subscribers, between networks, and so on; development of error protection methods.

The articles in connection are devoted to investigating the following problems which occur when developing computer networks: investigation of the principles of organizing computer networks; methods of data transmission in computer networks; information and program software; methods of noise-resistant coding; redundancy reduction methods.

On the whole the collection encompasses a quite broad if incomplete class of problems connected with the development of computer networks.

PART 1. ORGANIZATION OF COMPUTER NETWORKS

BASIC PRINCIPLES OF CONSTRUCTING A COLLECTIVE-USE DATA TRANSMISSION NETWORK

[By V. O. Shvartsman]

During the discussion of the material a significant amount of attention is given to problems which still must be solved.

Accordingly, the given article is divided into two parts: 1) some information is given about what has been done and what solutions are planned; 2) an effort is made to formulate the most urgent problems subject to study and solution.

The data transmission networks (PD) provide for exchange of information between computers and remote access to the computers of remote subscriber stations, and they are subsystems of the automated data gathering and processing systems, automated control systems, information retrieval systems, queueing systems, computer networks, and so on.

The PD [data transmission] networks can be provisionally divided into three types: communication networks, computer resources distribution networks, distributed networks.

The purpose of the first type of PD networks is data transmission from the terminals to the processing centers (computers) and between the centers. They are usually characterized by a large number of terminals and a small number of computers.

The second type PD networks are the data transmission subsystems in the computer networks. Their purpose is to insure the most efficient use of computer capacity and computer network resources.

The third type networks provide for future information exchange in the distributed computer networks with parallel solution of problems on several computers simultaneously.

One of the efficient versions appears to be the construction of a common-use PD network consisting of two levels: upper (second type) and lower (first type).

The variety of subscribers, their requirements and the problems solved by the network naturally leads to a difference and a variety of requirements imposed on the data transmission network (SPD). In the data gathering and processing systems, transmission of messages in one direction prevails, where the access times are reckoned in hours. During exchange of messages between computers the necessity arises both for the transmission of large data files and the exchange of short messages in real time. In the queueing systems and in the interaction of subscribers with the computers the basic operating modes are question-answer and dialog.[1] These modes have come to be called interactive modes. A short time for establishment of the connection and comparatively short data exchange sessions are characteristic of them.

The basic purpose of the SPD is the most complete possible coverage of the requirements of the potential users. The general list of services offered by a PD network is defined by the corresponding recommendations of the International Telegraph and Telephone Consultative Committee (ITTCC). In order specifically to define the user requirements, the requirements of the ministries and departments were studied in 1973 and 1977, and foreign experience was analyzed. On the basis of the data obtained, some generalized characteristics of the potential subscribers of the PD network were discovered:

Location throughout the entire territory of the country;

Data transmission in the amount of 10,000 characters per day for 80% of the subscribers;

Closure of the information flows inside the oblast for 40% of the subscribers;

The remaining distribution of the information flows 40% for Moscow and 40% for the republic centers;

Transmission of information in the amount of 10,000 characters for 90% of the subscribers in an operating session;

The demand for two-way information exchange by 25 to 30% of the subscribers (information about division into dialog and question-answer modes unavailable);

Organization of multiaddress and circular transmissions for 10% of the subscribers;

Necessity for priority servicing by categories of subscribers and by urgency of messages;

[1] By dialog in this case we mean the alternate transmission of information in both directions in which the transmission delivery time is greater than the pause between sessions, and by the question-answer mode we mean the mode in which short sessions are distributed at intervals somewhat exceeding the duration of an individual session.

Provision for information exchange between the subscriber units operating with different transmission speeds, codes and synchronization systems (synchronous, start-stop);

Data transmission with fidelity (error probability) no worse than 10^{-6} per character;

Use of 5, 7 and 8-element primary codes.

Load distribution by delivery times (excluding dialog) is characterized by the following data. The messages, the delivery time of which must not exceed 5 minutes make up 0.2% of the daily load, from 5 to 30 minutes, 22.6% of the daily load, from 30 minutes to 4 hours 24%, from 4 hours to 1 day 25%, more than 1 day 0.2% of the daily load.

The data presented above are approximate data in need of further refinement.

When developing a general-use data transmission network, consideration is given to the location of the potential subscribers throughout the entire territory of the country and the presence of means of communications among them. First of all a study was made of the possibility and expediency of the use of the existing switchable networks for data transmission: the general-use telephone network (TF-OP) and the subscriber telegraph network (AT).

The AT network was not designed when built to transmit data, and its characteristics do not satisfy the majority of the SPD user requirements. This network provides low speed (no more than 6 characters per second) and insufficient (on the order of 10^{-3} to 10^{-4} fidelity of the data transmission. The existing subscriber telegraph network is "opaque," for transmission takes place at a speed of 50 bits/sec with a 5-element code with the start-stop method of correction with 7.5-contact division. The network uses a call servicing system by one category of urgency with rejections when the equipment or the communication channels are busy, or in individual cases the communications are organized by the request system with waiting. Mixed numbering is used depending on the connection routing. The average two-way load on the subscriber line must not exceed 0.2 Erl (12 minutes) at the time of heaviest load (TP) on connection to the station and 0.15 Erl (9 minutes) on connection to a substation. The number of connections at TP must not exceed 5.

The low quality of the AT network with respect to fidelity, significant level of rejects when establishing connection as a result of overloading of the network, the long time required to establish connection, the low transmission speed -- all of these greatly limit the possibilities of using the AT network for data transmission.

In the future, a significant increase in the number capacity of the AT network and improvement of the transmission quality are planned as a result of introducing electronic switching offices and improved channel-forming equipment.

The TF-OP network also was not designed when built for data transmission, and its characteristics do not satisfy many of the data transmission subscriber requirements. This network has low transmission fidelity[1], insufficient level of long-distance automation, and it is heavily loaded with telephone conversations. Such parameters as nonuniformity of the group propagation time, interrupt time, false interference are not normalized in the TF-OP network inasmuch as they are not critical for telephone subscribers. In the TF-OP network these characteristics are appreciably worse than those proposed by the ITTCC for communication channels specially designed for data transmission.

The ITTCC-recommended additional services for the PD subscribers such as circular communications, conference communications, abbreviated dialing of numbers corresponding to the TF-OP network, just as the AT network, have not been provided for. An advantage of the TF-OP network is its branched nature and, consequently, insurance of data transmission in practice from any point of the country to any other.

The data transmission by the existing general-use switchable telephone network is realized by one of the following methods: in series with a rate to 200 bits/sec in the duplex or in the semiduplex modes; in series with rates of 600, 1200 (and in individual cases, 2400-4800) bits/sec in the semiduplex mode; parallel with a transmission rate to 40 characters per second in the semiduplex mode.

In order to prevent overloading of the transmission systems, the power level at the output of the data transmission equipment (APD) at the point of connection to the subscriber line must not exceed 1 milliwatt (0 decibels). In the APD provision must be made for the possibility of lowering the output level so that in the input of the closest transmission system the signal level will not exceed -15 or -17 decibels at the point with 0 relative level. In order to prevent overloading of the switching equipment the load created by the data transmission subscribers must not exceed the load characteristic of the telephone subscribers (the calculated load is 0.15 Erl, that is, 9 minutes at TP).[2]

Further expansion of the telephone network, conversion of the long-distance communications entirely to automated establishment of connections, improvement of the communications quality are planned by introducing quasielectronic automatic telephone offices and non-distance telephone offices, the introduction of new services for subscribers.

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[1] The error coefficient by bits on the average is no more than 10^{-3} to 10^{-4}, and in some cases it reaches 10^{-2}.

[2] The indicated load permits transmission of significant volumes of data. At a speed of 1200 bits/sec with error protection for a non-minute session, transmission of on the order of 50,000 characters is insured, that is, the daily requirement of 90% of the users.

A number of the data transmission subscribers (primarily the large computer centers) can use nonswitchable communication channels. The basic advantages of the nonswitchable channels are comparatively high transmission fidelity (10^{-4} to 10^{-5}), high reliability, absence of a restriction on the holding period, immediate readiness for operation. The use of nonswitchable channels is limited by economic arguments.

The USSR Ministry of Communications has permitted the use of the TF-OP network for data transmission at any time of day under the condition of fulfilment of the above-indicated requirements with respect to transmission level and load.

The TF-OP and the AT networks are meeting the demands of a significant part of the subscribers, but the subscriber demands for data transmission cannot be fully satisfied by the existing networks. Modernization of these networks to bring their indexes to a level that will satisfy the data transmission subscribers is clearly inefficient inasmuch as it would be necessary to improve the quality of the networks for all subscribers independently of whether they use data transmission or not, and the number of PD subscribers does not exceed 1-2% of the number of TF-OP network subscribers.

It appears more expedient to create a specialized data transmission network (of course on the basis of the primary network of channels of the united automated network of the Soviet Union [telecommunications] (UANSU)) corresponding to all the requirements of the data transmission subscribers. Here the use in the future of the existing communication networks by the PD subscribers which are satisfied with the characteristics of the AT and the TF-OP networks is not excluded.

The primary factor determining the set of services provided by the PD network to its subscribers is the adopted switching procedure.

The switching procedure is selected on the basis of a comparison of the requirements of the PD subscribers with the characteristics of the services which can be provided with the network with the investigated switching procedure. Inasmuch as it does not appear possible to make any exact forecast of the development of the requirements and characteristics of the data exchange, it is difficult to determine the optimal method of constructing the prospective PD network. Therefore we shall limit ourselves to the analysis of the trends in the variation of the communication characteristics for various switching methods.

At the present time in the PD networks there are three switching methods: switching of the channels (KK), switching of messages (KS) and packet switching (KP). The classical KK and KS methods have been analyzed in sufficient detail in the literature. The appearance of the KP method is giving rise to the necessity for supplementing this analysis, to say nothing of the fact that the KP [packet switching] is a new method, its potential has still not been fully discovered, and the essence of the KP method itself is far from uniquely understood. In confirmation of this let us note that it is

difficult to point out all of the KP networks with identical functioning algorithms. Therefore, for determinacy we shall briefly explain what is understood hereafter by KP [packet switching].

The subscriber of the KP network, just as the KS network, outputs a title with address together with the portion of information (packet); the KP junction has a memory for storing this segment of the information and the title. However, the KP junctions store and process small segments of data -- packets tens to hundreds of bytes long — which are small by comparison with the KS. An entry is not made in the long-term memory in the KP junctions (in contrast to the KS), and the transmission queue is limited to several packets At a high transmission rate in the interjunction and subscriber channels (on the order of tens of thousands of bits per second) the time the packet is in the network and the return time for confirmation of its delivery is units or fractions of a second, that is, the KP method is more similar to the KK method with respect to external, user characteristics.

When comparing the switching methods considering their execution on the basis of the time principle, the situation which was observed for the spatial principles of execution and consisted in polar difference of the KK and KS methods disappears to a significant degree. The modern station with time switching is a specialized computer which receives, processes, addresses and outputs information. When working with large information segments (thousands and tens of thousands of bytes -- so-called messages) the station is put in the KS class. If, on the contrary, information segments as short as possible (bytes, bits or significant modulation times -- SMT) are stored and processed, then we talk about KK. Here the KP method occupies an intermediate position, for the packet contains tens to hundreds of bytes. Thus, the appearance of switching offices with significant lengths of the stored and processed volumes of information (STM, bits, bytes, tens, hundreds of characters, packets, large files) permits the conclusion that there are no sharp boundaries between the different switching methods. Consequently, the technical principles of constructing the KK, KP and KS switching stations are similar.

The term "KK" turns out to be not exactly accurate considering what has been discussed above, for in the junctions with temporary switching, physical connection of the channels does not take place. In the same series with the terms "KS" and "KP" the term of the type "bit switching" would sound more precise. It would be still more correct to use a more general term in place of the word "bits" which would encompass the significant modulation time, bit, character, that is, the comparatively short segments of a message, the storage of which in the junction is equivalent with respect to its external characteristics to the "classical" KK method for the subscriber. The method of communication address transmission is highly significant for teaching techniques. For the KK method, address transmission before transmission of the message itself is characteristic; for the KP and KS methods the address is transmitted as part of the message.

The switching methods are distinguished, of course, not only by the length of the processed segment of information and the method of address

transmission; therefore it is possible also to classify them with respect to other attributes. For example, the division of the switching systems as queueing systems into three groups is generally recognized: a) systems with losses, that is, failures to service; b) systems with waiting in a queue for servicing; c) mixed systems, with waiting and with losses caused by limiting the waiting time or the length of the queue. The KK and the KS methods were considered to be classical representatives of groups a and b respectively. The KP method must be considered in group c. However, this classification cannot be recognized as absolute. For example, the presence in the KK system of such services as automatic calling in the case of being busy converts this system from group a to group b.

Another division of the methods of constructing a network into two classes is possible. The first class is characterized by the fact that the subscriber units interact directly with each other, and the regeneration of the signals and error protection can be realized only after passage through the entire communication channel. Let us call it the class of networks "with protection from subscriber to subscriber." In the second class networks, the signal regeneration and error protection are realized by sections, the subscriber units in this case do not interact directly with each other. Let us call it the class of networks "with protection by sections." The KK method usually gives networks of the first class, and the KS and KP methods, the second class.

One of the essential requirements of the subscribers is the restriction on the information delivery time. For example, for dialog and operation in the question-answer mode this time must be on the order of seconds or fractions of a second. At the same time the greater part of the information in an automated control system can be delivered at times equal to tens of minutes or several hours. The delivery time of the information is made up of the time of establishing the connection and the information delay time in the network. The time for establishing the connection[1] is required for transmission of the address of the called subscriber and the requests for various services, mutual recognition of the subscribers, and so on. A long connection establishment time is especially inconvenient for PD, and the more so, the higher the data transmission rate. Whereas for telephone transmission, a time of establishing a connection on the order of several tens of seconds to minutes is still intolerable, because the average length of the conversations is 2-3 minutes, and in this case an effort is made to decrease it (push button dialing, signalling along the common channel), in telegraphy it becomes approximately equal to the transmission time of one telegram: 300 characters per minute. For PD even with a rate of 1200 bits/sec the transmission time for an average codogram of 500 characters is 5 seconds, and at high speeds, even less. On transmission of large data files (in the packet processing mode) it is possible to tolerate the above indicated connection times. In the question-answer mode the transmission of the message

[1]The existing telephone-telegraph networks with KK have a connection establishing time of tens of seconds to several minutes.

itself can be done in a few seconds, and the pause for the operator to think about the response reaches tens of minutes; therefore it is inefficient to keep the channel busy with respect to the total KK system for the entire time of the dialog (sometimes several hours). Consequently, for each question and answer it is again necessary to establish the connection. For high speed PD, when the transmission of large data files between computers can be realized in fractions of seconds, the requirements of a short time of establishing a connection become especially critical as a result of high cost of the communication channels and the machine time.

A short connection establishment time, more precisely, the message transmission time in the presence of KP is achieved as a result of the following factors: 1) equality of the address and information transmission speeds; 2) partial transmission of the message as the packets are ready, not excluding the use of parallel channels; 3) a decrease in the delay by the small memory of the KP tandem centers; 4) better use of the carrying capacity of the channels than in the presence of KK. The first and last conditions appear also for KS, but the other two are absent. It is true that for KS the third condition can be insured by the fact that for urgent messages priorities are established.

The use of channels in the KP system by comparison with the KK system is improved as a result of the fact that the channel is not assigned to two subscribers, but it is used by sections for alternate transmission of the information of different subscribers. In addition, the channels in the opposite transmission direction can be used, just as in the KS, for transmission of different messages, whereas in the KK, the return channel even in the case of dialog is idle 50% of the time. Consequently, the use of channels in the KP is more than twice as great as in the KK. At the same time the presence of large flows of control information in the KP networks (in the existing networks up to 70% of all of the information circulating in the network) leads to a significant reduction in the use of the channels (by comparison with the KS network) for information transmission from the subscribers.

It is not necessary, however, to include the long connection establishment time in the KK algorithm. The use of the principle of transmitting the address as a whole and not character-by-character or at the same rate at which the information is transmitted, permits the connection establishment time in the KK system to be brought to one second or less. This method is being successfully used in modern electronic junctions with temporary switching.

It is not necessary to make the situation of incomplete use of the carrying capacity of the channels in the presence of KK initiated by the requirement of a small percentage of rejects absolute. On introduction of load control on the KK network, for example, by restricting the input load, the use of the channels can be improved significantly, which occurs in the KK networks with a request servicing systems, that is, with a system with rejects and waiting.

In the PD systems usually it is necessary to have several categories of urgency. In the electronic switching junctions, this is realized for any switching method. For KK it is possible to organize three categories of urgency: with ordinary rejects, with setup of a call for waiting (provisional priority); with forced release of the path busy with a connection of lower urgency (absolute priority). Theoretically the number of provisional priorities in the KK network can be increased by differentiation of the waiting time or with respect to categories of subscribers. For KS as a system with large memory the organization of any number of categories of urgency is possible. The KP method as a system with small memory in this respect is located between the KK and the KS methods, although as a result of the short information delay in the network with KP, the necessity for priority servicing usually is absent. Large memory size in the presence of KS makes it possible to store the previously transmitted messages, for example, arriving at night with output to the receiver-subscriber at the beginning of the working day.

As for information transmission fidelity, the KS and the KP methods as methods "with protection by sections" can in practice insure any fidelity, and the possibilities of the KK method are limited here.

One of the peculiarities of the KS is ease of organization of multiaddress (including circular) communications. In the KK junctions the organization of a multiaddress connection is complicated by high probability of the individual subscriber's being busy. In addition, it is possible if the terminal devices do not use feedback for error protection. Therefore the realization of multiaddress coupling in the KK networks is highly limited. A great deal of message storage time in the KS junction permits multiaddress communications even when some of the subscriber receivers are busy. The message is transmitted to them after release. The possibility of the organization of multiaddress communications in the presence of KP is somewhat less than for KS, in view of the short information storage time in the KP junctions. It is possible to counter this deficiency, for example, by interrupting the single-address communication transmission.

An advantage of the KS and the KP methods is insurance of communications between the subscriber terminals distinguished by the transmission rate, by the operating algorithm, the primary code, which is important for a number of automated control systems. For the KK, this possibility is absent, and only like subscriber units can operate in the KK network. The KS method offers the possibility of the interaction of subscribers included in the different communication networks, for example, in the specialized data transmission network, in the TF-OP and the AT networks. In contrast to the KS, the KP cannot play the role of the organizing network, but if at the boundaries of the KP network combined switching junctions can be created which operate outside the KP network by the KS method, that is, have large memory, and inside the network as KP junctions, then this problem is solved. This network would not have a number of advantages of the KP network, for large information delays could occur in the boundary modes. It is true that by comparison with the KS network here the delays in the

tandem offices would be reduced, but by comparison with the KS, the use of the main channels would become worse.

When analyzing the expenditures on realization of a network of one type or another it is necessary to consider three of its elements: the interjunction channels, the switching junctions and the subscriber sets with subscriber lines.

When invesigating the cost of the interjunction channels it is necessary to consider that the KK as a system with attachment of the channels to the subscribers for the entire connection time requires limitation of the individual bunches of channels for each transmission rate. As a result of fractionation of the total carrying capacity, which decreases the capacity of each bundle and also the losses for insurance of an admissible number of rejects in establishing a connection, the use of the interjunction channels in the KK systems does not exceed 30-40%. The KS and the KP systems as systems without attachment of the interjunction channels will permit the use of the carrying capacity of the channels more completely, usually by 80-90%, and during the periods of greatest loading, even 100%. Let us note that the worsening of the use of the channels in the presence of KK as a result of fractionation of the bunch can be decreased by introducing the dynamic redistribution of the proportion of the channels with different rates in accordance with the incoming load. The increase in use of carrying capacity of the channels in the presence of KK is achieved by statistical multiplexing of them. The "protection by sections" realized in the presence of KS and KP will permit more effective use of the interjunction channels than in the presence of KK.

As for the switching stations, the cost of the KK crossbar office is appreciably below the cost of the KS electronic office. However, for comparison it is necessary to consider additional possibilities (the multiaddress communications, transformation of rates and codes, and so on), improving the quality of servicing in the presence of KS and KP.

In addition, the appearance in the presence of KP and KS at the switching junctions of additional date transmission equipment is countered by the absence of the voice-frequency carrier telegraphy multiplexing equipment or analysis equipment for fractionation of the overall channel required in the presence of KK.

It must be noted that the KP requires more complex and, consequently, more expensive AP both on the part of equipment and software connected with the procedures for exchange and control of the loads to avoid network overloads. The decrease in cost of the AP in the networks with KP is achieved as a result of introduction of concentrators realizing the collection and breakdown of the packetsinto messages and other operations with coupling the functioning algorithms of the AP to the algorithms of the KP network. In any case it is obvious that the cost of the point of connection in the KS networks and, especially, KP, is higher than in the KK network.

On the basis of what has been discussed above it is possible to draw the following conclusions with respect to the KP method:

With respect to its essence (storage and switching in the junctions of tens, hundreds of bytes) the KP occupies an intermediate position between the KK and the KS;

With respect to internal characteristics (the presence of memory in the junctions, the simplex method of using the channels) the KP method is closer to the KS method;

With respect to external (consumer) characteristics (small information delays in the network and, as a consequence, the possibility of dialog less complete than in the KS, however somewhat better use than in the KK of the carrying capacity of the channels), the KP method is closer to the KK method.

A comparison of the technical-economic characteristic of the KK, KS and KP switching methods indicates that each of these methods has both advantages and disadvantages. This does not permit the conclusion to be drawn of the absolute advantage of any of the methods for the constuction of the specialized general-use PD network. The network with one switching method is in no position to fully satisfy the requirements of all of the subscribers. At the same time it is expedient to have a single network, for this insures interaction of the subscribers of different groups and the use in a single bunch of the most expensive part of the network -- the main channels.

Accordingly, a number of general-use specialized PD networks are being built for use of combinations of several switching methods: KS + KK, KK + KP, KS + KP. On this level the specialized collective-use PD network can, for example, combine the advantages of the KK network (the possibility of comparatively economical inclusion of a large number of subscribers and organization of the dialog communications) with the advantages of the KS network (convenience of realizing multiaddress communications, transformation of rates and codes). The latter is very important, for it permits insurance of the exchange of information of the PD subscribers included in the different subnetworks in the necessary cases: TF-OP, AT, PD-KK.

The PD networks usually are constructed by the radial-junction principle on the basis of switching stations of three levels. The necessity of the three steps of the hierarchy is caused by the following:

The requirement for the switching station located in the zone (region) for closure of a large intraregion flow;

The presence of large interzonal flows (including to Moscow) requiring combination in the main stations;

Concentration of the PD subscribers inside zones (in cities, economic rayons) and the demand for multiplexing of information at the locations of its appearance.

The upper level (the main stations) organizes the relaying of messages. The middle level (the zonal stations) is designed for inclusion of direct network subscribers located in the zone of this station and also of interaction with an isolated category of PD subscribers included in other networks and located in the same zone. The lower level stations insuring load concentration can be included in the zonal stations.

When creating computer networks it appears highly prospective to construct the PD network on the basis of the KP method on combination of two data transmission loads: transmission of the so-called datagrams and organization of virtual channels. In the first mode the sending computers breakdown the messages into packets which are transmitted over the network and are output to the receiving computers in arbitrary order. The ordering of the packets is done by the receiving computer. It is obvious that this transmission can be realized only in the case of the operating state of both subscriber computers of the network.

The virtual channel is organized by the request of the computer sender between the KP sender station and KP receiver station as a result of sending by the first KP station to the second of a special notification packet and receiving from the latter a confirmation packet permitting transmission of the message packets, after which transmission of the information packets takes place over the provisional (virtual) channel. This mode provides for obtaining ordered information, that is, the packets are received in the same order as they are transmitted and are not interrupted by packets of other messages. With respect to its external characteristics this mode is very close to the classical KK.

When developing the prospective data transmission networks it is impossible not to consider the operations performed in creating digital transmission methods and KS and the creation on the basis of them of integrated networks designed for transmission of different types of information. The transition to the digital channels completely expands the possibilities of the data transmission, for the transmission of data at rates on the order of 2400 to 4800 bits/sec and fidelity of about 10^{-4} is possible over the analog voice-frequency (switchable) channel, and transmission rates 1 to 1 1/2 orders higher with a fidelity of about 10^{-6} are insured over the digital channel (without application of special error protection measures). The digital switching stations permit establishment of the connections during the time reckoned in tenths of a second. That is, the digital synchronous networks constructed by the KK method will insure data transmission with fidelity index and connection establishment time better than the specialized analog KP networks, to say nothing of the lower cost of the former. The relative cheapness of the digital channels when transmitting digital data arises from the fact that if the ratio of the number of telephone subscribers to the number of PD subscribers in the case of analog systems is on the order of 100, then with digital systems even considering an increase in the proportion of the PD channels by several times this ratio increases to 1000. This fact indicates that in the integrated digital communications systems, specific expenditures on PD will be incommensurably smaller than

the expenditures on telephone transmission. Therefore the solution of the problem of selecting the switching method in the prospective PD network must be connected with the times for development of digital switching stations and systems for telephone communications. The digital synchronous KK network permitting the possibility of KP appears to be highly prospective.

The creation of a collective-use date transmission network requires the solution of very many complex technical and economic problems connected with the selection of the switching method, the principle of constructing the network (asynchronous or synchronous), the configuration of the network, the method of controlling the information flows in the network, insurance of absence of overloads in the network, the numbering principle, the development of the general and technical operating system, and so on. No less complex problems are also facing the developers of the PD hardware, that is, the switching stations and subscriber stations. The solution of many of these problems, including the problems of obtaining the required initial data goes beyond the limits of competency of the developers of the PD networks. Therefore an urgent condition of the successful solution of the problem of creating the collective-use PD network is combination of the efforts of the developers of the automatic control systems, computer networks and also the developers of the PD networks and hardware.

ISOLATION OF A DISCRETE SET OF SUBOPTIMAL VERSIONS OF DATA TRANSMISSION NETWORKS

[By Ye. I. Domanovskaya]

Introduction

When designing data transmission networks (SPD) different classes of problems arise in the search for the optimal combinations of the network structure, the functioning algorithms and the parameters of the elements. Usually the criteria are the economic, probability-time (VVKh) and (or) load characteristics. These indexes frequently play the role of type II restrictions in the optimization problems. For complex modern SPD, an estimate of the criteria is more and more frequently made on the simulation program models. For automation of the creation of such models and the solution of the SPD design problems, various versions of the packages of models are being developed [1-3].

The idea was implemented at the MEI Institute for Digital Computer Design Problems in the form of the SPOR system [6] and the algorithm for variation of the nonlocal search levels [7].

The algorithm is called the SKONO (random search -- concordation -- reference).

Execution and Experience in the Use of SKONO

A simplified version of SKONO was implemented on the Minsk-32 computer as part of the experiment planning system of the PIMSO simulation model packet [1]. This version also permits autonomous use outside PIMSO when using external programs for evaluating the target criteria. The system was turned over to the State Library of Algorithms and Programs in 1977. The version contains ~4000 FORTRAN operators, it requires four magnetic tape storages for operation. The experience in operating the SPOR-1 system was used during programming, and the A-automaton algorithm was borrowed completely.

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PART 2. DATA TRANSMISSION

PROBLEMS OF THE THEORY AND PRACTICE OF ERROR PROTECTION DURING DATA TRANSMISSION

[By O. F. Dmitriyev, L. F. Zhigulin, G. V. Popov]

At the present time a large amount of work is being done in the data transmission area both on the theoretical level, in particular, with respect to noiseless coding theory, and on the level of development of data transmission equipment, namely the means of protecting the transmitted messages from errors. It would appear that the created hardware must implement the modern theoretical achievements, but in reality this takes place extremely rarely.

The basic efforts in the development of the theoretical problems are aimed at improving the coding characteristics with error correction. In the created data transmission means basically codes are realized with error detection. The set of codes used changes little. For error correction without feedback the codes are used only in rare cases.

The causes of the observed break between theory and practice are quite varied. Most frequently they are seen in the complexity of realization of the coding methods and especially the decoding methods with error correction which the theory proposes. However, the complexity factor was taken into account by the theory of noiseless coding in essence from the time of its inception. In the earliest stages, only relatively narrow classes of noiseless codes were selected for investigation (linear, cyclic, iterative, and so on), which offer the theoretical possibility of avoiding the selection of all possible solutions and decreasing the rate of growth of complexity of the realization with lengthening of the code. At the present time noticeable progress has been made in this direction.

With all of its importance the complexity factor is far from the only obstacle to the use of the results of the theory of noiseless coding of data transmission equipment. The inadequacy in practice of the concepts of the nature of the discrete channels used (DK) and the conditions of transmission of discrete messages toward which theory is most frequently oriented has no less significance.

The basic results of noiseless coding theory are obtained under the assumption that the DK has no memory. In a relatively small proportion of the operations memory is considered, but its structure is simplified extraordinarily. Usually it is selected not so much on the basis of the data on the real nature of the errors in real channels as beginning with convenience of theoretical investigation or selection of the code. The representations of the channels in which the error sequence is a Markov chain of small connectedness or different type of component channels in which the error structure can at least vary from one code word to another, but for each word it is very simple (independent errors with different probabilities, independent errors or single packets of errors of limited length, and so on) can serve as examples.

The real DK can be considered channels without memory or with such simple memory only in rare cases. At the present time the DK of certain space radio channels and cable digital communication systems are frequently considered channels without memory. Correspondingly, the methods of the theory of noiseless coding are finding practical application basically only in these channels (more precisely, in the first of them, for protection from errors is still considered unnecessary for digital channels).

The majority of the real DK have highly complex memory. This is explained to a great extent by the use of the existing network of TCh and TG radio relay and cable channels, which on creation of it was designed not for data transmission, but for telephone and telegraph communications. It is known that in main line channels with frequency multiplexing the basic sources of errors are short term interruptions, a reduction in signal level, and pulse interference. They lead to the formation of groups of errors of different structure with complex nature of alternation. The efforts to represent such errors in the form of isolated packets of limited length and to apply codes that correct the individual packets for control of them demonstrated their groundlessness essentially immediately after they were undertaken. The codes taking into account the real nature of the errors have been poorly developed in theory.

The theory of noiseless coding more frequently begins with the idea that the channels are directed only in one direction or the use of return channels is inexpedient. In practice this situation is encountered comparatively rarely, for example, data transmission from re-entering spacecraft or circular data transmission to a large number of addresses. Most frequently, along with direct channels there are also return channels. Thus, telephone networks used for data transmission traditionally offer channels in both directions to the subscribers. In addition, the return channel can be used also for error protection of the messages transmitted in the forward direction which essentially changes the approach to error protection itself. In particular, in the absence of feedback the effective use of the introduced redundancy is achieved by lengthening of the code in which its different words are affected by the errors more or less uniformly. In the presence of feedback, to increase effectiveness an effort is made, on the other hand, to use nonuniformity of the affecting of the short words by the errors. Whereas in the direct-action systems, in addition to selection of the codes, the design of

the error protection reduces to the development of a decoding algorithm, in systems with feedback it includes the choice of the procedure for using the return channel.[1] The problems of such selection have been poorly resolved in the noiseless coding theory.

In connection with the noted and other factors, the role of theory in the error protection practice does not reduce to solving the problems of selecting optimal codes and methods of decoding them with error correction traditional for this theory. The role of the development of proper representations of the nature of the errors in the real DK, the use of these representations for efficient selection of the codes detecting errors and the protection algorithms using the returning channel will increase significantly. This selection usually is realized on the basis of the prediction of the behavior of the data transmission systems (SPD) with different known codes and algorithms.

Although the theory and practice of construction of the SPD have developed intensely over the extent of approximately the last 20 years, these problems cannot be considered solved. The variation of the channels used, the complication of the requirements on the indexes, the use of new hardware are giving rise to urgency of the theory and practice of error protection also at the present time.

The individual aspects of the stated topics are developed more in detail below. The material presented in this article reflects the point of view of the authors based primarily on their own experience. It does not claim to completely encompass the problems that are touched on.

Noiseless Codes and Feedback in the Existing Data Transmission Systems

The majority of the existing SPD implement the error protection method that uses error detection by blocked linear (n, k) code and repeated transmission of the words in which the errors are detected. Basically three types of algorithms with ask-to-repeat-repeat are used: with waiting, going back two words (blocking of one word) and going back $M \geq 4$ words. The first of them is executed in the majority of AP YeS [subscriber panels of the unified system](second model AP-2, AP-4, AP-61, AP-70, and so on) [12], the second of them in the AP-2 (TAP-2), AP-3, "Akkord 1200" and with some modification in the APD [data transmission equipment] "Mikro-TG" and "Mikro-TF", and the third in the AP ZZA (APD "Sbor").

Error detection in the systems with ask-to-repeat-repeat is realized basically

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[1] Let us note that there are a number of documents on the procedures for information exchange in the data transmission networks. They encompass the agreements on the structure of the formats, the interaction of the stations, error protection, that is, they pertain to various levels of interaction of the stations. In this article the problems of error protection are considered without considering any limitations to the existing agreements.

by the iterative and the truncated cyclic codes. Out of the cyclic and truncated cyclic codes with short lengths, the Abramson code (31, 25) and the codes obtained by truncation of it (23, 17), (15, 9) with generating polynomial $g(x) = x^6 + x^5 + x^2 + 1$ and code distance $d = 4$ (AP ZZA or APD "Sbor") are used. The recommendations of the ITTCC and the All-Union State Standard 17422-72 [13] for synchronous SPD with medium-speed DK with error detection independent of the primary code and asking-to-repeat over a narrow band feedback channel prescribe the use of codes (976, 960), (496, 480), (256, 240) or (136, 120) with $g(x) = x^{16} + x^{12} + x^5 + 1$ and $d = 4$ obtained by truncation of the Abramson code (32767, 32751). These codes are used in the series of subscriber sets of the unified computer system (first model AP-2, AP-3) and APD ("Akkord 1200," "Mikro-TG" "Mikro-TF"). For the high-speed DK (4800 baud) provision is also made for the possibility of using the truncated cyclic code with $g(x) = x^{24} + x^{23} + x^7 + x^5 + x^2 + 1$ and $d = 6$. The simplest iterative codes with subcodes of the rows (8, 7) and columns (n_2, $n_2 - 1$) correspond to All-Union State Standard 20687-75 [14] (the rows are the characters according to All-Union State Standard 13052-74 [22]. Here for the AP-2 provision is made for three values of the number of rows n_2: 17, 32, 46 ($n = 136, 256, 376$). For AP-4, $n_2 \leq 138$.

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ABSTRACTS FROM THE BOOK 'INFORMATION EXCHANGE IN COMPUTER NETWORKS'

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UDC 621.391.98

BASIC PRINCIPLES OF CONSTRUCTING COLLECTIVE-USE DATA TRANSMISSION NETWORKS

[Abstract of article by V. O. Shchvartsman]

[Text] A study is made of the requirements imposed by the subscribers on a data transmission network (PD) and the possibilities of satisfying these requirements by the PD networks constructed on the basis of various switching methods. On the basis of a comparative analysis of the characteristics of the channel switching methods, messages and packets, it is recommended that combined switching methods be used in the collective-use data transmission networks. Some problems are noted, the solution of which is necessary for the creation of the collective-use data transmission network.

UDC 621.39:681.3

METHODS OF INFORMATION DISTRIBUTION IN COMPUTER NETWORKS

[Abstract of article by V. G. Lazarev]

[Text] When building computer networks one of the most important problems is the selection of the structure of the computer network, the switching method and the control of the data flows. In this article some of the paths of solving the given problems are discussed.

There are 5 illustrations and 5 references.

UDC 621.39

REMOTE PROCESSING SYSTEM OF A MULTIPROCESSOR COMPUTER COMPLEX

[Abstract of article by V. I. Perekatov]

[Text] Various principles of constructing remote processing systems are compared. Preference is given to the systems which are a set of universal means available for systems use from which the required number of simultaneously existing specific subsystems can be created. There is 1 illustration.

UDC 681.327.8:513.834

ISOLATION OF A DISCRETE SUBSET OF SUBOPTIMAL VERSIONS OF DATA TRANSMISSION NETWORKS

[Abstract of article by Ye. I. Domanovskaya]

[Text] In this paper the problem of isolating a set of suboptimal versions with variation of the qualitative, structural and discrete parameters of the data transmission network is formulated. The SKONO retrieval system is proposed which modifies the known principle of strengthening the separating hyperplane with training on the reference peaks. Within the framework of the system, the definition of the reference of the vectors is expanded, a nonlinear search algorithm is proposed using the conversion of the concordation. A random search apparatus is included, and estimates of the quality of isolation of this suboptimal set are proposed. The results are presented from the solution of the test and applied problems indicating an increase in the rate of convergence of the algorithm without worsening of the search quality.

There are 11 references.

UDC 621.327

PROBLEMS OF THE THEORY AND PRACTICE OF ERROR PROTECTION WITH DATA TRANSMISSION

[Abstract of article by O. F. Dmitriyev, L. F. Zhigulin, O. V. Popov]

[Text] A study is made of the individual aspects of the development of the theory and practice of constructing data transmission systems within which noiseless codes are used for error protection.

There are 24 references.

UDC 621.327

DATA TRANSMISSION RATE AND FIDELITY OVER THE YES-EVM-AP-2 REMOTE PROCESSING CHANNEL

[Abstract of article by O. F. Dmitriyev, A. M. Dolgushev]

[Text] The calculation procedure proposed in this paper can be used to predict the probability characteristics of the remote processing channels of the unified computer system operating by the exchange algorithm with waiting for confirmation of receipt.

There are 5 illustrations, 7 tables and 5 references.

UDC 681.3.06

PROBLEMS OF INTEGRATION OF NONUNIFORM DATA BASES

[Abstract of article by L. A. Kalinichenko]

[Text] A study is made of the problems of constructing the integration systems of nonuniform data bases providing for the possibility of simultaneous use by the applied program of several program and information incompatible data bases (local or territorially distributed) as a united whole. The selection of the conceptual diagram of the data base is substantiated, and a criterion is proposed which must be satisfied by the mapping of the internal models of the data onto the conceptual model for integration of them. A study is made of the structure and the basic functions of the SIZIF integration system of nonuniform data bases.

There are 7 illustrations and 27 references.

UDC 621.39

METHODS OF IMPROVING THE RELIABILITY OF INITIAL DATA IN AUTOMATED PROCESSING SYSTEMS

[Abstract of article by O. M. Ryakin]

[Text] A study is made of the problems of improving the reliability of the initial data in the stage of their preliminary processing. Formatted documents are used as the formalized representation of the initial data. Primary attention is given to the construction of universal systems for noiseless input of data capable of being adapted to specific applications by tuning. As the universal method of representation of the controlled couplings in the document information, it is proposed that the apparatus of the logic of predicates be used on the basis of which the primary concepts connected with the problems of monitoring and locating the errors are formalized. In the second part of the article a study is made of the problems of noiseless coding for detection and correction of errors in the requisitions.

There are 4 illustrations and 25 references.

UDC 681.3.06.51

AUTOMATED METHODS OF VERIFYING COMPUTER COMPLEX SOFTWARE

[Abstract of article by O. M. Ryakin, N. F. Panova]

[Text] A discussion is presented of the problems of verification, the significance of verification from the point of view of obtaining reliable software. A survey is presented of the existing verification systems.

There are 4 illustrations and 22 references.

UDC 621.391.15

CHINESE REMAINDER THEOREM AND CONTROL OF FUNCTIONAL TRANSFORMATIONS

[Abstract of article by V. M. Amerbayev]

[Text] A study is made of various methods (ideal, remainder, interpolation) of submersion of information words (messages) in redundant structures generated by the Chinese remainder theorem. The corresponding switching equations are derived. Classes of functions are described which fall under the code protection system with minimum code redundancy with special assumptions for organization of calculations in finite fields.

There are 16 references.

UDC 621.391

METHODS OF CONSTRUCTION AND REALIZATION OF LINEAR CODES THAT CORRECT ERROR PACKETS

[Abstract of article by I. M. Boyarinov, G. L. Katsman]

[Text] A study is made of the problems of the construction and realization of codes that correct error moduli and packets The code parameters and the complexities of the coding and decoding algorithms are compared.

There are 2 illustrations, 3 tables and 12 references.

UDC 621.391

USE OF CODES WITH PARALLEL STRUCTURE FOR THE PROTECTION OF INFORMATION FIELDS AND SYSTEMS

[Abstract of article by R. G. Biyashev, Yu. N. Cherkasov, S. S. Yurov]

[Text] A study is made of the use of codes with parallel structure for information field protection. The Lagrange codes based on the basic

Lagrange polynomials form the basis of the codes used in the given paper.

There is 1 illustration and five references.

UDC 621.391

METHODS OF CODING DISCRETE TIME SOURCES WITH GIVEN QUALITY CRITERION

[Abstract of article by Yu. M. Shtar'kov]

[Text] A survey is presented of the known results with respect to coding sources with given quality criterion using codes distinguished from the random block codes by some ordering of the structure. In particular, a great deal of attention is given to the tree codes and the algorithms for decoding them, lattice and sliding block codes.

There is 3 illustrations and 26 references.

UDC 621.391

APPLICATION OF THE NUMBERING METHOD IN CODING PROBLEMS

[Abstract of article by V. F. Babkin]

[Text] A study is made of series with restrictions of a quite general nature called Markov. For such series numbering methods can be constructed the basis for which is arithmetic operations. Examples are presented of the application of a numbering method to the solution of certain data transmission problems.

There are 12 references.

UDC 631.391

ASYMPTOTICALLY EFFECTIVE QUANTIZING WITH WEIGHTED DIFFERENCE-STEP QUALITY CRITERION

[Abstract of article by V. F. Babkin, M. M. Lange, Yu. M. Shtar'kov]

[Text] A study is made of the characteristics of uniform and nonuniform quantizing and also subsequent block decoding with variable and fixed rate as applied to a source without memory with continuous alphabet and letter-by-letter measure of distortion with loss function of a defined type. For small values of the average distortion and long block lengths for two quantization strategies and two methods of block coding of the quantum numbers asymptotic estimates of the rate and average distortion are obtained. The obtained estimates are compared with the epsilon entropy.

There are four references.

[415-10845]

10845
CSO: 1863

ABSTRACTS FROM THE JOURNAL 'IZVESTIYA AKADEMII NAUK SSSR. TECHNICAL CYBERNETICS'

Moscow IZVESTIYA AKADEMII NAUK SSSR. TEKHNICHESKAYA KIBERNETIKA in Russian No 5, 1980 pp 218-224

UDC 519.31:62-50

OPTIMUM GUARANTEED ESTIMATES OF INDETERMINACIES BY MEANS OF ELLIPSOIDS. III.

[Abstract of article by Chernous'ko, F. L.]

[Text] A guaranteed approach is developed for estimating indeterminate values in dynamic systems, one based on approximation of the region of indeterminacy and the region of attainability by means of ellipsoids.

UDC 681.322.06:51

ALGORITHM FOR SOLUTION OF THE PROBLEM OF COATING

[Abstract of article by Alekseyev, O. G.]

[Text] An algorithm is proposed for solving the problem of a coating, one based on ideas of the method of branches and bounds. An auxiliary problem is used to estimate the lower bound of the solution, one which permits estimating without weakening the condition that the variables be whole numbers. The simplicity of solution of the auxiliary problem and high precision of the estimate of the lower bound make the algorithm under consideration highly effective. The results of computational experiments on a digital computer are evaluated.

UDC 62-50

SIMPLEX METHODS OF DIRECT SEARCH

[Abstract of article by Rykov, A. S.]

[Text] Simplex methods of minimizing an n-dimensional scalar function are examined. A generalization of simplex methods is proposed, one based on increasing the number of possible directions of simplex displacement. The construction of simplex algorithms is described, convergence is demonstrated and their properties are compared.

UDC 62-50

THE PROBLEM OF AUTOMATION OF CONTROL SYSTEM PLANNING AND METHODS OF AUTOMATIC CONTROL THEORY

[Abstract of article by Solodovnikov, V. V.]

[Text] The author presents the general principles and structure of the construction of special software to automate the planning of systems for control of technical objects. A brief analysis is given of methods of automatic control theory from the point of view of their possible use as part of that software.

UDC 62-50:003.6

PRINCIPLES OF CONSTRUCTION OF STRUCTURES OF DECENTRALIZED DATA PROCESSING SYSTEMS

[Abstract of article by Kengerlinskiy, G.A.]

[Text] The task of synthesis of the structure of a decentralized data processing system is examined. It is shown that the method of data processing and the structural properties of the system, about which there is no apriori information, are caused by the character of the interconnection intrinsic to the elements. Two kinds of interaction possible in principle are analyzed: by element and by group. The former corresponds to a parallel, and the latter to a series-parallel method of data processing. A general principle of synthesis of two classes of structures realizing those methods has been formulated. The obtained structures differ from one another within the framework of the established class by the degree of centralization of processing and the configuration of the data transmission network.

UDC 519.2:338.984

ALGORITHM FOR SEARCH FOR A COST-OPTIMAL PLAN ON A PREDICTION GRAPH

[Abstract of article by Dryuchenko, L. D.]

[Text] The author examines the task of optimum selection of the plan for achievement of a predictable scientific-technical problem on a set of alternatives presented by a prediction graph. The optimality criterion is the minimum of total expenditures on realization of the plan. A selection algorithm based on a special completion of the prediction graph is obtained. An example is presented.

UDC 62-50:519.95

PROGRAM SYSTEM FOR SOLVING LINEAR OPTIMIZATION PROBLEMS

[Abstract of article by Lebedev, V. Yu.]

[Text] The author describes a program system for solving linear programming problems, based on a BESM-6 computer. In essence, it is a specialized compiler that can be used for the computer transformation of recordings of such tasks in a language similar to an algebraic into ALGOL programs for their solution by a method

with the use of penalty functions, or into programs for generation of compact representations of matrices of their conditions in a format adopted in library realizations of the simplex method. The system input language is described informally, with emphasis on illustrative examples.

UDC 007.52:681.51

METHOD OF PURPOSEFUL FORMATION OF CLASSES OF SITUATIONS

[Abstract of article by Brutyan, Kh. K., Klykov, Yu. I., and Mkrtchyan, L. V.]

[Text] A method of purposeful formation of classes of situations is examined, one based on the principle of stepwise construction of classes according to the results of analysis of the goal of functioning of a controlled object. A method is proposed for the automatic construction of strategies by means of classes of situations in the form of logical formulas in the case where the set goal is attainable. The efficiency of practical application of the method in situation control systems is stressed.

UDC 519.682.1

SIMULATING THE DISTORTED PERCEPTION OF THREE-DIMENSIONAL SCENES

[Abstract of article by Gorodetskiy, V. I., and Shishov, S. A.]

[Text] Algorithms are proposed for simulating distortions of the semantic content of information presented in a formal language in transmission and registration equipment. Equipment distortions are simulated by means of a stochastic grammar, the output sentences of which are monitored by means of syntactic analysis procedure to determine whether the input information information belongs to the input description language, and in the case of a negative response undergo treatment to eliminate lack of structural and semantic correspondence with the initial language.

UDC 62-50

STATIONARY PROBABILITIES IN THE SYSTEM WITH DISCIPLINE PREFERENTIAL SEPARATION OF THE PROCESSOR

[Abstract of article by Pechinkin, A. V.]

[Text] For the system M|G|1 with discipline servicing of the requirement with minimum servicing of length, and if there are several such requirements, of uniform distribution of the instrument among them, a producing function of the stationary distribution of the number of requirements in the system is found.

UDC 519.2

NOT FULLY ACCESSIBLE CIRCUITS DURING CONSIDERATION OF RECURRENT REQUESTS

[Abstract of article by Falin, G. I.]

[Text] A general approach to the study of not fully accessible circuits with recurrent requests has been developed, and a number of asymptotic theorems are demonstrated.

UDC 519.217

ASYMPTOTIC EXPANSION FOR MOMENTS OF TIME OF STAY IN AN ACCESSIBLE SET OF STATES OF A SINGLE CLASS OF UNILINEAR MASS SERVICE SYSTEMS

[Abstract of article by Ayupov, N. S., and Ivnitskiy, V. A.]

[Text] A generalized unilinear mass service system is examined, one characterized by an arbitrary graph of transitions by states and an arbitrary distribution of servicing length during Markov incoming flow. A method is given for determining recurrent correlations for calculating the coefficients of asymptotic decompositions of probabilistic characteristics of the system. Recurrent formulas are presented for calculation of the coefficients of expansion in an asymptotic series of moments of time when the system was in a fixed set of states.

UDC 519.21

ALGORITHM FOR FINDING OPTIMUM STRATEGIES IN CONTROLLED SEMI-MARKOV PROCESSES OF MULTIPLICATION AND DEATH

[Abstract of article by Andronov, A. M.]

[Text] A controlled semi-Markov process of multiplication and death with a finite number of states is examined. It is assumed that a single ergodic class forms during any control of the process state. An algorithm is proposed for finding optimum controls, one based on specifics of the process under consideration. The results of computer realization of the process are presented.

UDC 519.2

OPTIMUM CONTROL OF DATA PROCESSING DURING RANDOM FAILURES

[Abstract of article by Brodetskiy, G. L.]

[Text] The problem of optimum organizing of the storage of intermediate results in systems with failures which can destroy data in storage is examined. Optimum control was found during use of storages on a single intermediate level. Formulas are presented for the mean time required to solve a system problem during storage of intermediate results on any fixed intermediate levels.

UDC 519.2

ESTIMATE OF RELIABILITY FROM RESULTS OF TRUNCATED OBSERVATIONS

[Abstract of article by Ushakov, I. A.]

[Text] A method is proposed for estimating quantiles of the empirical distribution of the working time before failure on the basis of the results of tests during which a portion of the elements is removed before onset of the failure (truncated observations). The method is based on a posteriori estimation of the results of truncated observations.

UDC 51.521.391

PREDICTIVE EXPANSION OF SWITCHING FUNCTIONS

[Abstract of article by Aleksich, T., and Nikolich, S.]

[Text] A method is proposed for expansion of switching functions, one which permits obtaining for each function a flowchart consisting of a universal part and a part realizable by existing standard modules. A large saving in the used elements is noted. The proposed method of function expansion is suitable under conditions of the present-day integrated circuit technology.

UDC 62-507.001.2

METHOD OF HIERARCHIC DECOMPOSITION AND SYNTHESIS OF NATURAL AUTOMATA

[Abstract of article by Topol'skiy, N. G.]

[Text] A method is proposed for multilevel hierarchic decomposition of automata with a large number of states. A flowchart is presented for the the algorithm of decomposition synthesis of an automaton in the presence of a given limitation on the complexity of description of its parts. A method is proposed for seeking the most promising ways to accomplish hierarchic decomposition. A method of constructing automaton flowcharts by parts is described.

UDC 62-507.019.3

VERIFYING TEST FOR AN ASYNCHRONOUS POTENTIAL AUTOMATON CODED BY TRANSITION TABLE COLUMNS

[Abstract of article by Danilov, V. V., and Zhirabok, A. N.]

[Text] A method is proposed for the construction of a verifying test for asynchronous automata coded by the Lew method. The basis of the method under consideration was the idea of checking the values of each internal variable separately, and not of the states as a whole. In that case a corresponding word is formed for each variable, and then a test input set is given and the true value of the tested variable is identified. The method permits detecting singular and multiple permanent defects.

UDC 681.142.2

PRACTICAL METHODS OF SATISFYING PARALLEL STRUCTURES OF PROGRAMS

[Abstract of article by Val'kovskiy, V. A.]

[Text] A group of algorithms for the deparallelization of programs and a package of their parallel branches is described. The algorithms form the base of an experimental development of a system of deparallelization of FORTRAN programs.

UDC 681.142.1.01

ASYNCHRONOUS PROCESSES. II. COMPOSITION AND MATCHING

[Abstract of article by Varshavskiy, V. I., Marakhovskiy, V. B., Peschanskiy, V. A., and Rozenblyum, L. Ya.]

[Text] A formal apparatus is examined, one which can be made the base for construction of a theory of synchronous processes. Operations are proposed which permit describing the coordinated joint work of complex discrete devices. The developed apparatus can be used, in particular, for setting exchange protocols in data transmission and interface equipment synthesis systems.

UDC 62.506.222.001.57:621.317

USE OF DECLARATIVE KNOWLEDGE TO SOLVE SOME PROBLEMS OF TECHNICAL DIAGNOSTICS

[Abstract of article by Malinovskiy, V. P., and Fomenko, I. M.]

[Text] An approach is proposed for the solution of problems of technical diagnosis, one based on application of their representations in the space of states. Two examples of representation of problems of diagnosis are examined: searching for defects in a finite automaton with a memory and in a combination flowsheet.

UDC 62-50

INVERSE PROBLEMS OF THE DYNAMICS OF CONTROLLED SYSTEMS. NONLINEAR MODELS

[Abstract of article by Petrov, B. N., and Krut'ko, P. D.]

[Text] Methods have been developed for the synthesis of algorithms for control of the motion of nonlinear systems. The procedure is based on determination of the forces realizing the designated trajectories of motion. Flowsheets are examined for the practical implementation of synthesized algorithms as a function of the volume of measured information characterizing the state of the controlled object.

UDC 62-50:681.51

APPLICATION OF THE METHOD OF CHARACTERISTICS IN TASKS OF OPTIMUM CONTROL OF DETERMINED SYSTEMS

[Abstract of article by Babich, O. A.]

[Text] The author examines the task of optimum control of a determined nonlinear object during its transfer from its initial position to a fixed multiformity. The task of synthesizing control is solved for functionals, including an arbitrary component according to the method of the minimum of generalized work. Two examples of control synthesis for a second-order system are examined.

UDC 62-50

ON THE THEORY OF DISCRETE INVERSE SYSTEMS

[Abstract of article by Yaksoo, Yu. I.]

[Text] Linear discrete dynamic systems in the form of equations of state are examined. A simple condition of reversibility of a multidimensional dynamic system is obtained, formulas are derived for calculating the parameters of an inverse system and the controllability and observability of an inverse system are analyzed.

UDC 681.513.66

PRECISION OF ADAPTIVE IDENTIFICATION WITH AN ADJUSTABLE MODEL

[Abstract of article by Danilin, A. B., Rutkovskiy, V. Yu., and Yadykin, I. B.]

[Text] The authors investigate the dependence of the precision of adaptive identification with an adjustable model on the error of observation of the state of the object of control. The constructed procedure is used for adaptive calibration of corresponding sensors.

UDC 62-50

INVESTIGATION OF THE MODEL OF A CORRELATION-EXTREME SYSTEM FOR TRACKING NOISY SIGNAL DELAY

[Abstract of article by Ponomarenko, V. P.]

[Text] The author examines the task of investigating the working conditions and nonlinear control effects in a single-loop correlation-extreme systeme system for tracking noisy signal delay. The system stability conditions in a quasi-stationary regime are determined and an analysis is made of the influence of nonlinearity of the correlator characteristics on the character of movements in the system.

UDC 62-506:518.5

OPTIMIZATION OF TERMINAL CONTROLS BY GRADUAL IMPROVEMENT

[Abstract of article by Batenko, A. P.

[Text] A simple computer-oriented method is proposed for the synthesis of quasi-optimal terminal controls, one using an adaptive random search algorithm. The method permits finding as the finite number of iterations in the class of continuous functions quasi-optimal terminal controls with any previously set closeness to the extreme during mathematically strict observance of boundary conditions. The algorithm of the method has been realized in the form of a package of applied programs in FORTRAN. An example is presented.

UDC 62-506:548.5

EXPANSION OF THE AREA OF APPLICATION OF RELAY SYSTEM STABILITY CONDITIONS

[Abstract of article by Rudnev, S. A., and Faldin, N. V.]

[Text] A relay system with a nonlinear object of control is examined. It is shown that the condition of stability of auto-oscillations obtained by Ya. Z. Tsypkin for relay systems with a linear object remains valid also for a number of systems with a nonlinear object of control.

UDC 62-504.3

CURRENT PLANNING OF AN AMPLITUDE-LIMITED TEST SIGNAL FOR IDENTIFICATION OF ONE CLASS OF DYNAMIC OBJECTS

[Abstract of article by Isayev, K. V.]

[Text] The author examines the task of active identification of a dynamic object of the regression type with basic operators of the type of Hammerstein operators. A method is proposed for the current planning of an optimum test signal for a fixed time interval. The possibilities of the example are illustrated by examples.

UDC 518.9

CHECK OF CORRECTNESS OF MATHEMATICAL MODELS OF COMPLEX INFORMATION-MEASURING SYSTEMS

[Abstract of article by Anisimov, A. V., Belov, Yu. A., Lyashko, I. I., and Makarov, V. L.]

[Text] The Floyd method of program verification is used to prove that a mathematical model is adequate for a given physical description. A definition of the mathematical model is presented as a system of correlations adequate to prove the adequacy of the model for a given physical description. The given procedure is extended to the case of arbitrary models given by a structural description.

UDC 62-50

ESTIMATION OF THE QUALITY OF FUNCTIONING OF COMPLEX TECHNICAL SYSTEMS WITH CONSIDERATION OF THE PRECISION CHARACTERISTICS

[Abstract of article by Savin, S. K.]

[Text] The law of distribution of errors of a complex technical system is found and its properties are investigated. On the basis of that law, indicators are obtained for estimating the quality of functioning of complex systems.

UDC 62-50:007:62.529

CONSTRUCTION OF DISCRETE LAWS OF CONTROL DURING INCOMPLETE OBSERVABILITY

[Abstract of article by Shidlovskiy, V. I.]

[Text] An approach is proposed for the construction of discrete laws of control of a multidimensional object, when not all coordinates of the latter are accessible to direct measurement. The law to be synthesized is determined from the condition of approximation of the state vector of the discrete system to the state vector of another dicrete system with the same object of control, the regulation of which is determined by known methods without consideration of incomplete observability of the state vector. The presented algorithms can be used to synthesize multidimensional discrete systems during any correlations of orders of the state and control vectors.

UDC 519.2

TWO COMMENTS ON THE ARTICLE 'PROBABILISTIC MODEL OF BUFFER MEMORY OF A CONTROLLING COMPUTER COMPLEX WITH GROUP SELECTION' BY V. A. POPOV AND A. L. LITVINOV

[Abstract of article by Vikarski, D.]

[Text] An error committed in the reference article is corrected. A theoretical discussion is presented of the assertion of the authors of that work regarding the monotonous dependence of some system characteristics on the coefficient of variation of the interval between the arrivals of messages in the system.

[56-2174]

2174
CSO: 1863

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